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UNION PACIFIC RAILROAD.

REPORT

OF

THOMAS C. DURANT,

Vice-President and General Manager,

TO THE

BOARD OF DIRECTORS,

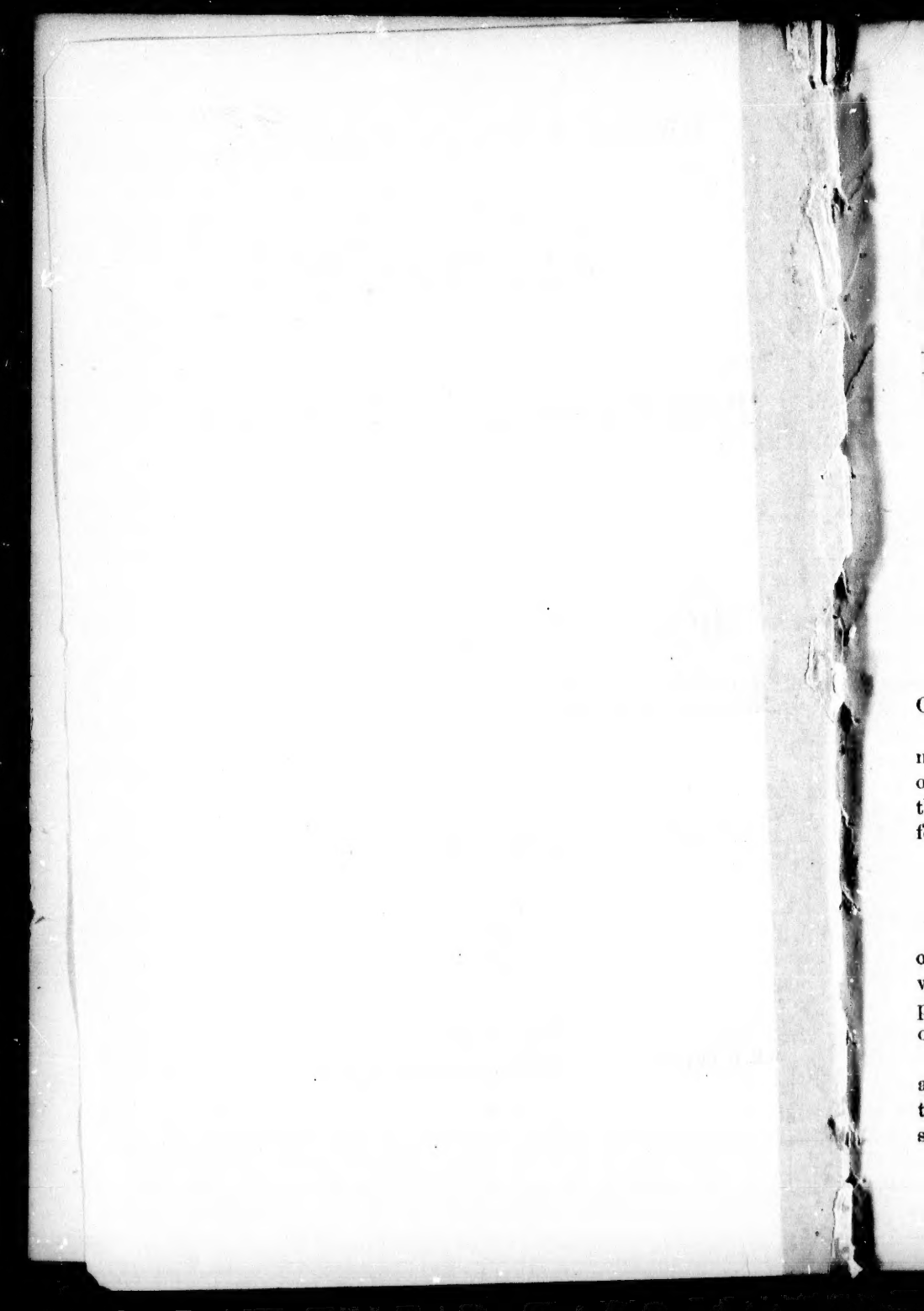
IN RELATION TO THE SURVEYS MADE UP TO THE
CLOSE OF THE YEAR

1864.

New York :

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1866.



UNION PACIFIC RAILROAD.

REPORT OF THOMAS C. DURANT,

VICE PRESIDENT,

TO THE BOARD OF DIRECTORS,

In Relation to the Surveys made up to the close of the year

1864.

OFFICE OF THE UNION PACIFIC RAILROAD COMPANY, }
No. 13 William street,
NEW YORK, April 10, 1865. }

GENTLEMEN :

In accordance with the resolutions of your Board, authorising me to continue my supervision and direction of the operations of the engineer department in making the necessary surveys for the final location of the road, I have the honor to submit the following

REPORT:

During the year 1863, the surveys necessary for the location of the first one hundred miles of the road West of Omaha City were made; and the work of constructing and equipping this portion of the road was placed under contract early in the season of 1864.

Two engineering parties were also employed in 1863, to examine what were considered to be the most difficult portions of the route West of the Great Platte Valley. The results of these surveys are embraced in the published "Report of the or-

ganization and proceedings of the Union Pacific Railroad Company."

In the spring of 1864, three field parties were organized for the purpose of continuing the explorations and experimental surveys in the mountains west of the head of Great Platte Valley; and one party to complete the location of the second division of one hundred miles west of the *Initial point*, fixed by the President of the United States, on the west bank of the Missouri River, in Township 13 E, Range 15 W., Section 10, near Omaha City, Nebraska.

The parties designated for experimental surveys were placed in charge respectively of Mr. Jas. A. Evans, Mr. F. M. Case, and Mr. Samuel B. Reed, Division Engineers; and the locating party under the charge of Mr. Ogden Edwards, Division Engineer.

Mr. Silas Seymour was appointed Consulting Engineer of the road, to date from January 1st, 1864.

The reports of Messrs. Evans, Case and Reed, Division Engineers in charge of experimental surveys (see Appendix A, B and C), will be found to contain much interesting and valuable information respecting the difficult and mountainous country through which the road is to pass, between the Platte Valley and Great Salt Lake City. It was found impracticable to extend the surveys west of Salt Lake City during the past season.

Mr. Evans started his surveys at Camp Walbach, in the valley of Lodge Pole Creek, a tributary of the South Platte, and ran a line up that valley to its source, at the summit known as "*Cheyenne Pass*"; and thence down the westerly slope of this range of the Black Hills to the Laramie Plains; crossing the tributaries of the Laramie and North Platte Rivers, and passing to the northward of the main range of the *Medicine Bow Mountains*, to the summit or divide of the continent known as "*Bridger's Pass*"; and thence along the valley of Muddy Creek to the head of Bitter Creek, the valley of which he followed to its intersection with *Green River*. Thus completing a continuous line of surveys and levels from the head of the Great Platte Valley to the crossing of Green River, the valley of which, and that of the Rio Colorado, which is its continuation, forms a very marked feature in the topography of the con-

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CAMP WALBACH FROM THE EAST.

SURVEY OF 1864.

UNION PACIFIC RAIL ROAD

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continent, by dividing its drainage almost longitudinally from a point considerably to the north and west of the *South Pass*, to the head of the Gulf of California, so that our line must cross its valley upon any route that can be projected.

By reference to Mr. Evans' report, it will be seen that large quantities and varieties of timber abound in the Black Hills and Medicine Bow Mountains; and that indications of large deposits of coal are found at several points along the route.

The distance from Camp Walbach to Green River is $269\frac{99}{100}$ miles.

Assuming the elevation of Camp Walbach to be 7,000 feet above tide, Mr. Evans reports the summit of the Black Hills, or "*Cheyenne Pass*," to be 8,656. The summit of the Medicine Bow Mountains, or "*Rattle Snake Pass*," to be 7,560. The divide of the continent, or "*Bridger's Pass*" to be 7,534, and Green River, at the termination of his line, 6,092 feet.

The grades upon this portion of the route may be brought within the maximum fixed by Congress, by tunnelling the Cheyenne Pass, and elongating the line about six miles for the purpose of developing the grades.

Mr. Case, in his report, gives some important information respecting the Passes through the Black Hill ranges, south of the Cheyenne Pass, some of which is obtained from actual surveys; and some from other sources which may be considered more or less reliable.

He estimates the Pass at the head of Boulder Creek to be 11,900 feet above tide. The Pass between the head of the North Fork of the South Platte and one of the heads of Snake River, an affluent of the *Blue*, to be 11,500 feet. The Pass between the head of Tarryall Creek and Indiana Gulch, also a tributary of the Blue, to be 11,432 feet. The Pass between the head of the *South Platte* and the *Blue River*, known as "*Hoosiers' Pass*," to be 11,500 feet. A survey was made through this Pass, from a point in the valley of the South Platte, about forty-eight miles easterly, to a point in the Valley of the Blue, about eighteen miles westerly of the summit, from which it appears that a tunnel two and a half miles in length will be required, in order to reach the summit with our maximum grade; and also that the

line is very indirect, requiring a distance of 145 miles to make 76 miles of westing, between Denver and the mouth of the Blue.

There are an abundance of good timber and building stone along this route, but it is estimated that snow falls to a greater depth in the vicinity of Hoosier Pass than in any other part of Colorado. In the winter of 1861-2 the total fall was thirty-seven feet; and in one storm it fell to a depth of eleven feet, at *Georgia Gulch*, situated upon Swan River, one of the tributaries of the Blue.

In relation to "Berthoud Pass," situated nearly west of Denver City, at the divide between the head of Clear Creek and Moses Creek, a branch of the Blue, Mr. Case gives the results of his survey made in 1862, as reported to the Hon. John Evans, Governor of Colorado Territory, from which and his profiles, it appears that a tunnel of three and $\frac{22}{100}$ miles will be required at the summit; and that the entrance to the tunnel would be 4,820 feet above, and a distance of 57.8 miles from Denver City:

Upon the map accompanying Mr. Case's report, the following elevations above tide are given:

Denver City.....	5,302 feet
Tunnel.....	10,050 "
Berthoud Pass.....	11,410 "

After giving the foregoing results, Mr. Case proceeds to give a more minute report of his surveys up the Valley of the Cache La Poudre Creek, a northern tributary of the South Platte, commencing at La Porte and connecting with Mr. Evans' line, at the crossing of the Laramie River, from which it appears that the elevation of the summit of the Black Hill range, which he names "*Antelope Pass*," situated at the divide between the headwaters of Dale and Willow Creeks, is 593 feet lower than the *Cheyenne Pass*, as surveyed by Mr. Evans, making Antelope Pass 8,063 feet above tide, or 3,347 feet lower than the Berthoud Pass. This elevation can be reached from both directions with our maximum grade, without a resort to tunneling. Mr. Case suggests several improvements which can be made in his line, and among others a line up the Valley of *Crow Creek*, which to my mind promises many advantages over the routes heretofore examined.



DELIVERED BY F. MCASE, DIV. ENG. UNION PACIFIC RAIL ROAD.

STEAM BOAT BUTTE NORTH OF STONEWALL CANON.

Oct. 28th 1864.

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The timber along this route is rather sparse, but large quantities of superior granite are found to the south, and at no great distance from the line. The indications of coal are not very promising.

The distance from La Porte to Antelope Pass is $44\frac{2}{10}$ miles, and to Station 1,360 of Mr. Evans' line, at his crossing of Laramie River, $69\frac{5}{10}$ miles.

The altitude of La Porte is estimated at 5,084 feet above tide, making an ascent to Antelope Pass of 2,979 feet to be overcome in a distance of $44\frac{2}{10}$ miles.

From the report of Mr. Samuel B. Reed, it will be seen that his surveys were commenced in the northwestern part of *Great Salt Lake City*, near Jordan River; and that he ran a continuous line from this point, near the westerly base of the Wasatch range of the Rocky Mountains, in a northerly direction to the mouth of Weber Cañon; and thence easterly up the Valley of Weber River to the mouth of Chalk Creek; thence up the Valley of Chalk Creek, and across the headwaters of Bear River, to the head of the Muddy River and Black's Fork of Green River; and thence down the Valley of Black's Fork, to and across Green River, to an intersection with Mr. Evans' line in the Valley of *Bitter Creek*, at Station No. 10,409 $\frac{5}{10}$ of Mr. Reed's line, and Station No. 13,508 of Mr. Evans' line. A line was also run from the Weber Valley, at the mouth of Echo Cañon, up the Valley of Echo Creek, crossing the divide between Weber and Bear Rivers at the head of Echo; thence following the tributaries of Bear River, to an intersection with the line above described, in the Valley of Sulphur Creek.

Another line, known as the "*Timpanogos Valley line*," was also run, commencing at a point in the Weber Valley near the mouth of Chalk Creek; thence up the Weber Valley to and across "*Kamas Prairie*," to the Valley of the Timpanogos; thence down the Timpanogos Valley to the Valley of Utah Lake; and thence to a point in the Tuilla Valley $106\frac{2}{10}$ miles from the Weber Valley line, near the mouth of Chalk Creek.

The following altitudes are taken from Mr. Reed's tables :

Great Salt Lake City	4.285. 8
Summit at head of Chalk Creek	7.834.
Summit at head of Echo Creek	6.879. 4
Summit between Bear and Muddy Rivers.	7.567.
Summit between Green River and North Branch of Bitter Creek	7.175.
Junction of Mr. Evans' line	6.315.
End of line in Tuilla Valley	4.243.
On Kamas Prairie	6.667.
Mouth of Chalk Creek	5.645.

The distance from the initial point in Great Salt Lake City, *via* the Echo Cañon line, to the intersection of Mr. Evans' line, is $223 \frac{48}{100}$ miles.

As between the Weber Valley and Timpanogos Valley lines, the comparison seems to be decidedly in favor of the Weber Valley line. The line *via* Echo Cañon seems also more favorable than the one *via* Chalk Creek, being better in alignment and grades, and having 955 feet less elevation to overcome, although the tunneling is 1,300 feet more than on the Chalk Creek line, and it does not lie so contiguous to the coal and timber regions along the northern slope of the Uinta Mountains, as the more southerly line of Chalk Creek.

The country adjacent to the routes above described was thoroughly examined by the engineers in charge of the surveys, so that it may be regarded safe to conclude that, with some slight and unimportant amendments, the lines, as traced, show the substantial difficulties that must be overcome in the construction of the road upon any of the routes described ; some of these difficulties appear quite formidable ; but they may all be surmounted by the use of skill, energy and perseverance.

I do not regard the result of the surveys already made as affording sufficient data to enable the Company to make a definite location of the route of the road. They indicate, however, beyond a doubt, that a practicable route can be obtained which will meet the requirements of the law of Congress, as to grades

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UNION PACIFIC RAIL ROAD
SURVEY OF 1864.



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and curves; and also the wants of the Government and people, as a means of transport across the Continent. Other routes are to be examined during the present season, during which it is also hoped that the surveys may be extended beyond Salt Lake, to the western boundary of Nevada.

In order to meet the requirements of Congress, as well as the just expectations of the Government and people, with reference to the early completion of the road, it may be necessary, at no distant day, to determine upon one or more proper locations for the erection of furnaces, rolling mills, and machine shops, for the manufacture of rails, cars, and other machinery, required for the construction and equipment of distant and isolated sections of the road, in advance of a continuous track from the Eastern terminus upon the Missouri River. With a view to this contingency, the information contained in the reports of the Division Engineers, with reference to timber, and deposits of iron ore, and coal, contiguous to the routes examined, must be regarded as of great importance to the Company.

The surveys were continued Westerly from the termination of the first one hundred miles, during the summer and fall of 1864, to the One Hundredth Meridian of longitude, a distance from Omaha of about two hundred and fifty miles, beyond which point it was not considered safe to go, on account of the armed hostility of the Indians. From the termination of this survey, no line has yet been run to the head of the Great Platte Valley (or eastern base of the Rocky Mountains), a distance of about three hundred and twenty-five miles.

It has been ascertained, however, from observation, that there are no natural obstacles in the way of constructing a road from almost any point on the One Hundredth Meridian that may be established by the President of the United States, to the best point of crossing the most easterly range of the Rocky Mountains.

With a view to the rapid progress of the work, the first question to be determined is the proper point for the line to leave the western end of the Great Platte Valley. The location of the line across the One Hundredth Meridian, as well as the entire route west of the first one hundred miles of the road, can-

S. B. REED DIV ENG'Y, U. S. ARMY, DEL.

UNION PACIFIC RAIL ROAD

SURVEY OF 1864.

The largest & deepest Eng'g. Bldg. in the U. S. at Washington D.C.



CAMP NO. 22. STATION 22.000. TETON VALLEY

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APPENDIX A.

Report of JAMES A. EVANS, Division Engineer, of Exploration from Camp Walbach to Green River, made in
1864.

MONTROSE, Penna., *January 3, 1865.*

Sir,—I have the pleasure of submitting the following report of explorations and surveys, extending from the eastern slope of the Black Hills, to Green River :

On reporting for instructions, at Omaha, Nebraska, early in April last, it was found, in consequence of the non-acceptance of one of the appointments made by the company, that the work originally designed for two distinct parties would have to be done by one. By giving that single corps additional strength, the supposition was entertained that it could cover the ground. Subsequent events fully justified the arrangement ; hence the portion of line first assigned to the undersigned for examination, formed but part of the country covered by this communication.

Preparations for our journey up the Platte River having been completed, I left Omaha on the 16th day of April, looking to Old Camp Walbach, at the eastern slope of the Black Hills, and on Lodge Pole Creek, as our point of commencement.

In consequence of Indian difficulties on the border, I made application to Brigadier-General Mitchell for authority to procure escort, which was very cheerfully granted by him, and very promptly complied with by Colonel Collins, then in command at Fort Laramie.

Our line of travel was on the north side of the Platte River as far as Fort Kearney, where we crossed, thence on the south side to Julesburg, on the south fork, distant from Omaha 400 miles. At this point, in consequence of the hostility shown by the Cheyenne tribe of Indians, I telegraphed to the commander at Fort Laramie (Col. W. O. Collins) for escort. With promptitude highly commendable, he immediately sent a detachment, composed of a lieutenant and twenty men of the Eleventh Ohio Volunteer Cavalry.

At Julesburg we crossed the south Fork of the Platte River, a short distance below the mouth of Lodge Pole Creek, up the valley of which we continued our journey. Some forty miles up this tributary we met our escort, they having crossed the country from Fort Laramie for the purpose of intercepting, or rather meeting the party; they remained with us until the completion of our field work in September.

We reached the deserted ruins of Camp Walbach, situated in latitude $41^{\circ} 21' N.$, longitude $105^{\circ} 15' W.$, distant by travelled road from Omaha, 575 miles, on the 16th May. The instructions given me contemplated my noting the country along the line of travel.

As far as Fort Kearney the country is favorable for the construction of a railroad; and the same is true of the entire route until we approach to within fifty miles of the Black Hills. For that entire distance, the uniformity of surface, the superior character of the material and the small amount of mechanical work required, as bridge superstructure, masonry, &c., combine to make this portion of the line everything that can be desired. When we consider that such is the topography of the country extending over nearly ten degrees of longitude, we can safely come to the conclusion that a region more favorable for railroad purposes does not exist in this or any other country.

As we approach to within fifty miles of the mountains, the valley of Lodge Pole Creek gradually changes; the distinctive smoothness of surface ceases, giving place to a more broken topography—by no means making necessary heavy or expensive grading, yet in marked contrast to the extreme uniformity of the lower part of its course, and of the Valley of the Platte.

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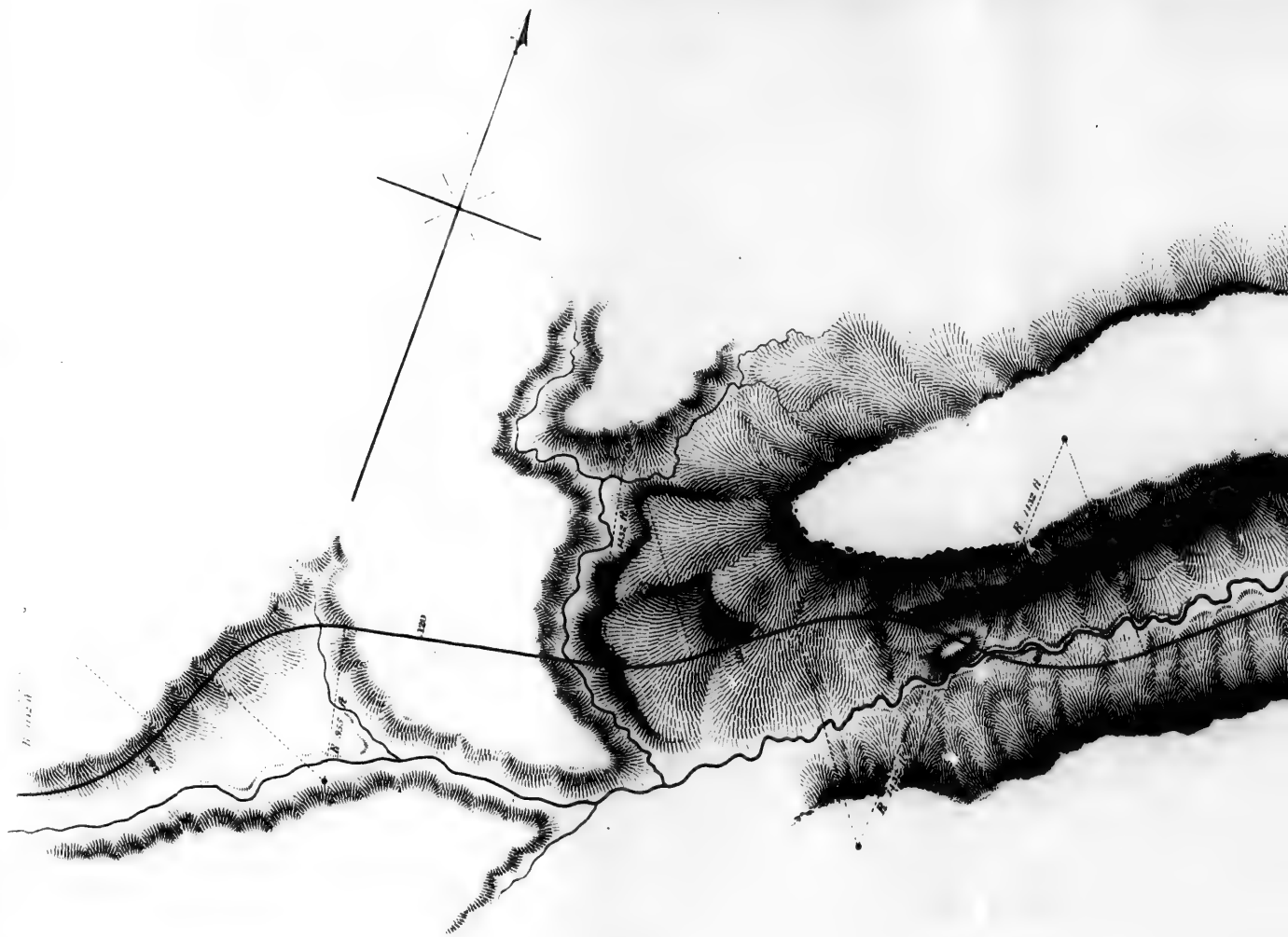
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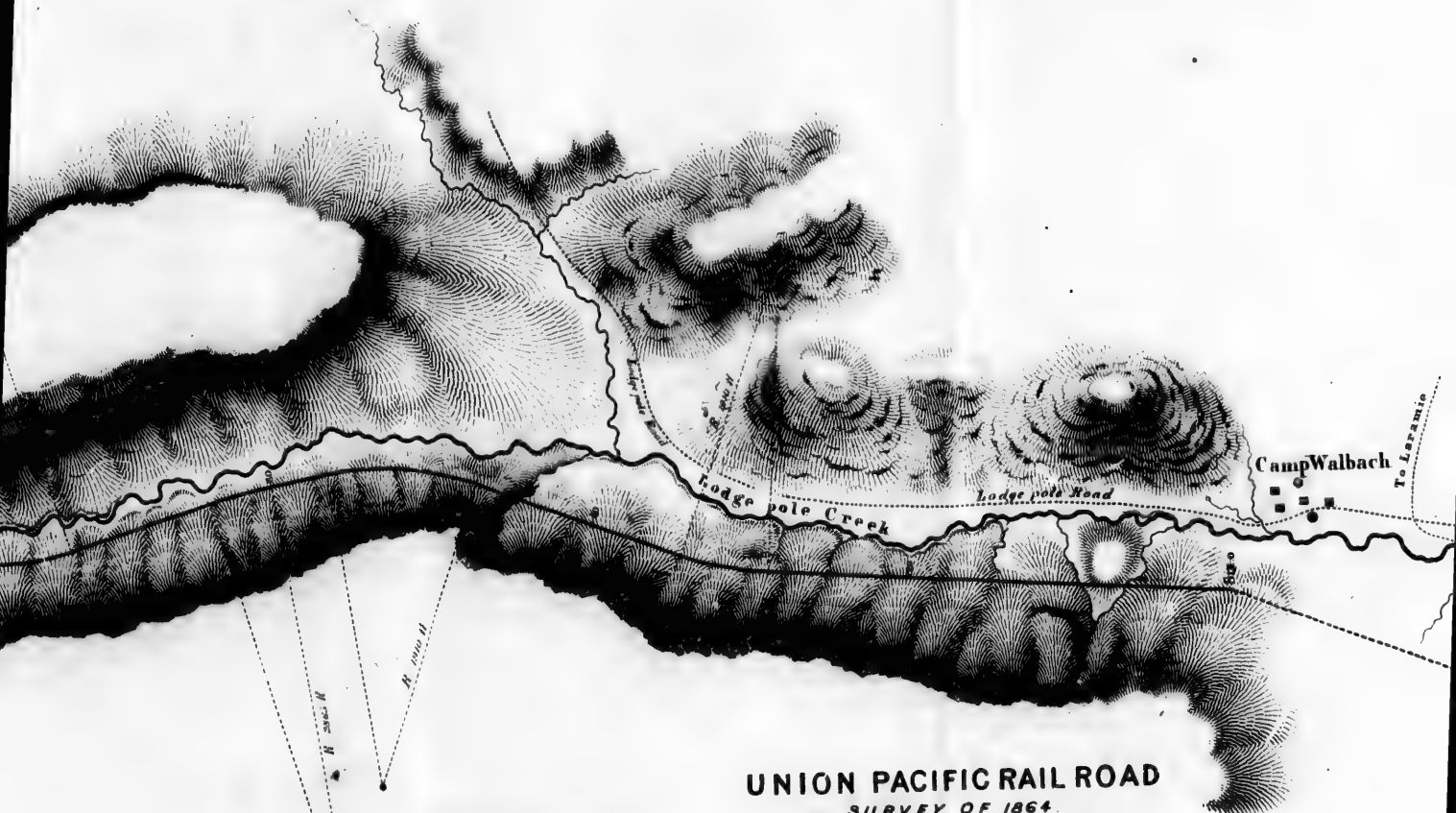
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UNION PACIFIC RAILROAD
SURVEY OF 1864.
BLACK HILLS

VICINITY OF OLD CAMP WALBACH.

Scale 800 feet to 1 inch

The Mayer & Knapp Eng. & Arch. Co. 449 Broadway N.Y.

Geo. A. Evans Div. Eng.

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of line above referred to is the scarcity of timber. Confining my observations to the Platte valley, it may be stated that as far west as a point 80 miles above Fort Kearney, all the timber that seems to be available occurs at Loup Fork of the Platte, and on the Platte itself; principally cottonwood, with some cedar interspersed.

At and near Cottonwood Springs, distant from Omaha 285 miles, from Fort Kearney 90, the bluffs on the south side of the valley tend towards the river, approaching to within half a mile of the stream, and continuing parallel with it for some distance above and below. Here, in a district very broken, and somewhat difficult of access, a considerable growth of cedar is found, of excellent quality for cross-ties and kindred purposes. From this point to the mountains no timber is found, neither on the streams nor contiguous to them. The manner of supplying this portion of the line will be hereafter indicated.

BLACK HILLS.

On reaching the base of this chain of mountains, after a reconnaissance of the country in the vicinity of old Camp Walbach, I fixed the starting point of my survey directly south of the ruins, at a point distant 1,200 feet, and on the opposite bank of Lodge Pole Creek. The line follows that tributary of the South Platte to its source at the summit of the range, overcoming, in a distance of $14\frac{11}{100}$ miles, an elevation of 1,612 feet, giving an average grade of $114\frac{2}{100}$ per mile. It was found necessary to undulate this grade, not, however, to an extent seriously to interfere with any traffic this part of the road may be called upon to do.

The accompanying map and profile will show the direction and arrangement of grades.

A sufficient supply of timber (yellow pine and spruce pine) can be obtained in this mountain chain, and contiguous to the line, to supply all the wants of construction, besides furnishing a large surplus for the line to the eastward, and for fuel.

The character of the material in excavation is indicated on the profile; specimens have been furnished. On the eastern slope it will prove to be granite, of different degrees of hardness and coarseness; on the western slope, sandstone exclusively. A tunnel 1,500 feet long is found necessary at the summit.

The gradient used from the summit of this range to the Laramie Plains is 2.5 per 100 feet, 132 feet per mile. A lighter grade cannot be used over this ground without a large sacrifice of profile and direction. A reference to the accompanying profile will show this grade to be continuous for $8\frac{17}{100}$ miles. Should this, or any other line crossing the Black Hills be the one finally adopted, additional or extra power will be required to make the ascent; knowing this to be the case, and knowing too, that any attempt to use a lighter gradient over the ground would result in giving a very expensive line, I came to the conclusion that a sufficient saving in grades could not be made to compensate for the additional material it would be necessary to move.

Efforts were subsequently made by me and the party under my charge, to obtain a more favorable crossing of this range of mountains, but without success, the details of which will be submitted in their proper place.

By reference to the profile, it will be seen that on the western slope of the Black Hills depression amounting to 1,080 feet is overcome by means of a gradient of 2.5 per 100 feet. To reduce this to our maximum grade would require additional distance as follows :

43,200 feet at 2.5 per station = 1,080 feet.

49,091 " at 2.2 per " = 1,080 "

5,891 " additional distance required.

By using a 2.2 grade, 116 feet per mile from the mouth of the tunnel, say station 780 to station 881, there inserting a switch, and running back half the distance, or 2,945½ feet, then switching again, we would be placed 99 feet lower at station 881 than we are now, and could reach the foot of the slope from that point with a grade of 116 feet per mile, striking the table at the foot, as we do now, which I consider important.

My reason for fixing upon station 881 as a point from which to switch back, is, that the requisite distance can be obtained there on a smoother slope, less cut up by ravines than elsewhere.

LARAMIE PLAINS.

Soon after leaving the base of the Black Hills, our line crosses the main fork of the Laramie River.

From thence to the Rattlesnake Pass, at a point where the Medicine Bow range of mountains drop off into low ranges of hills of comparatively slight elevation, our line crosses the drainage of that mountain chain, and of the plains at nearly right angles. Some bridging will be necessary on this part of the route. For amount see item of "Bridging." The principal streams crossed are—

Main Fork of Laramie River.
Right hand Fork " "
Cooper's Creek.
Rock or Frappe's Creek.
Medicine Bow River.

The amount of grading necessary for the distance is light, the alignment excellent, the material good.

The Medicine Bow Mountains, distant from our crossing of the Laramie River 16 miles, are in good part covered with timber suitable for all kinds of construction. As our line proceeds westerly we gradually approach them, at Cooper's Creek we are distant but $2\frac{1}{2}$ miles; from thence we run nearly parallel with the range until we flank or turn it by the Rattlesnake Pass.

The large amount of timber found here renders easy the solution of a problem that would otherwise be extremely difficult to solve, viz., the supply of timber for that part of the line west of the North Platte River, a country desert in character, destitute of vegetation, and impossible to avoid by any line following the valley of the Platte. This consideration alone should, and doubtless will, have great weight in the comparison of routes—when we consider, further, that the timber of this region is indispensable for the purpose of developing and making available the coal of Bitter Creek, too much importance cannot be attached to its fortunate proximity to the line.

Distance from the main fork of Laramie to the head of Rattlesnake Pass, 69 $\frac{1}{2}$ miles. The only difficult point for that distance

is the dividing ridge between Rock Creek and the Medicine Bow River.

Should it be considered desirable to lessen the gradients and obtain a smoother profile, by a sacrifice of distance at that point, a detour of four or five miles to the northward will accomplish it, as indicated by the dotted line on the map.

The fixed points on this section of line are, in my opinion, Station 1,520, near the crossing of the main Laramie—the crossing of the Medicine Bow River—the head of Rattlesnake Pass.

Should explorations already or hereafter to be made, demonstrate the practicability of a line *via* the South Fork of the Platte and the Cache-la-Poudre Creek, the first point mentioned above would have to be made for the purpose of avoiding the broken ground at the base of the Medicine Bow range of mountains.

Our descent from the head of Rattlesnake Pass is made by a gradient of 116 feet per mile for five miles nearly.

This Rattlesnake Pass is a marked depression in the spurs forming the termination of the Medicine Bow range, which here loses the distinctive character of a mountain chain, dropping off into ridges of slight elevation, stretching far to the northward, and forming the eastern boundary of the

VALLEY OF THE NORTH PLATTE.

The line here offers nothing remarkable, aside from the crossing of the North Platte River, which proves to be extremely favorable, being rectangular, and affording reliable foundations for piers and abutments. The amount of bridging required is 600 feet. It will be seen that our line makes considerable southing to reach this point. A short distance below our crossing the river enters a cañon extremely crooked, bounded by perpendicular escarpments of sandstone rock, which feature it continues to have so far as the mouth of Pass Creek, some fifteen miles below.

Any line *via* Bridger's Pass will, from necessity, make this crossing of the river a fixed point, there is no means of avoiding it; hence I look upon the favorable character of the crossing as fortunate.

After passing the Rattlesnake Pass, the country changes sensi-

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bly—everything indicating the approach to a barren region. The abundant pasturage of the Laramie Plains being here replaced by a stunted growth of sage brush. Grass is only found on the water courses, the more elevated points being almost entirely destitute of vegetation. This feature of extreme barrenness increases in intensity until the western terminus of the division is reached at Green River.

The topography of the valley of the North Platte River immediately bordering on the stream, and in the vicinity of our line, has been already referred to. The perpendicular walls of sandstone commence a very short distance below our crossing on the *eastern* or right bank. On the *western* side, the slopes are gentle for nearly four miles, from thence the vertical rock borders closely both sides of the river, continuing, as stated before, to the mouth of Pass Creek.

After crossing this river, our line continues down it to nearly the commencement of the cañon. We then leave the valley, and by easy grades reach Sage Creek, striking the latter stream about two miles above its mouth.

No information can be given in a report of this part of the line other than what may be conveyed by the accompanying map and profile. The grades are light, the amount of excavation necessary small; building stone for what light structures may be needed, abundant.

Thirty-one and one half miles from the crossing of the North Platte River, brings our line to the summit of

BRIDGER'S PASS.

Although this is a point of some geographical importance, as forming the water-shed of two oceans, nothing formidable is encountered either in approaching or leaving it. The maximum grade on the eastern side is 2.05 per 100 feet. On the western, 2.18 per 100, and only for short distances.

The approaches to this and the Rattlesnake Pass are the points where the greatest obstructions from snow may be looked for. The location of the line in the vicinity of both has been made with reference to such contingency. In every instance where the nature of the ground admitted without sacrificing

profile, the line has been thrown to the right, by that means placing valleys and depressions between it and the prevailing northwesterly winds.

Soon after crossing the divide or head of Bridger's Pass, we reach a branch of Muddy Creek, down which our line runs to its junction with the main stream, which we follow a distance of fifteen miles to a point where it bends strongly to the southward to form its junction with Little Snake River, of which it is a tributary.

The valley of Muddy Creek, as far as followed by our line, is extremely narrow, having but little flat or bottom land on its margin—much of the distance being what is termed in the phraseology of the mountains, a cañon. Our line, in consequence, comes in frequent contact with the stream, and several changes of channel will be necessary.

By a judicious arrangement of grades, the work is rendered light in character. Where changes of channel are necessary, the embankment will require protection on the exposed side, by a lining of loose rock (rip-rap), the material for which purpose is convenient, abundant, and easily quarried. This stream (Muddy Creek), it may be stated, is comparatively small and insignificant,—in June last it was nearly dry. During the melting of the snow its section is much increased.

From what observation I was able to make, I estimate its flood section to be 180 square feet.

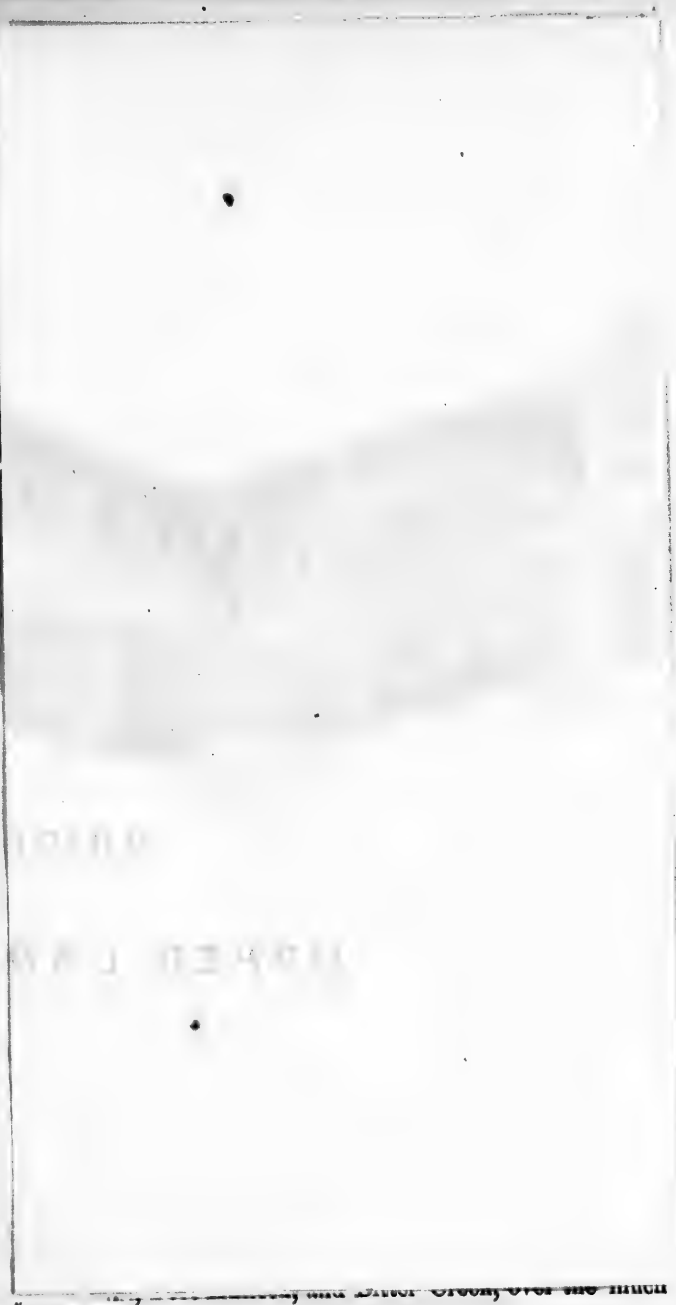
After leaving the elbow of Muddy Creek, the line passes over a country of long, flat slopes, crossing Bridger's Fork of Muddy. By means of a tributary and easy grades, we reach the broad table-land at the head of

BITTER CREEK.

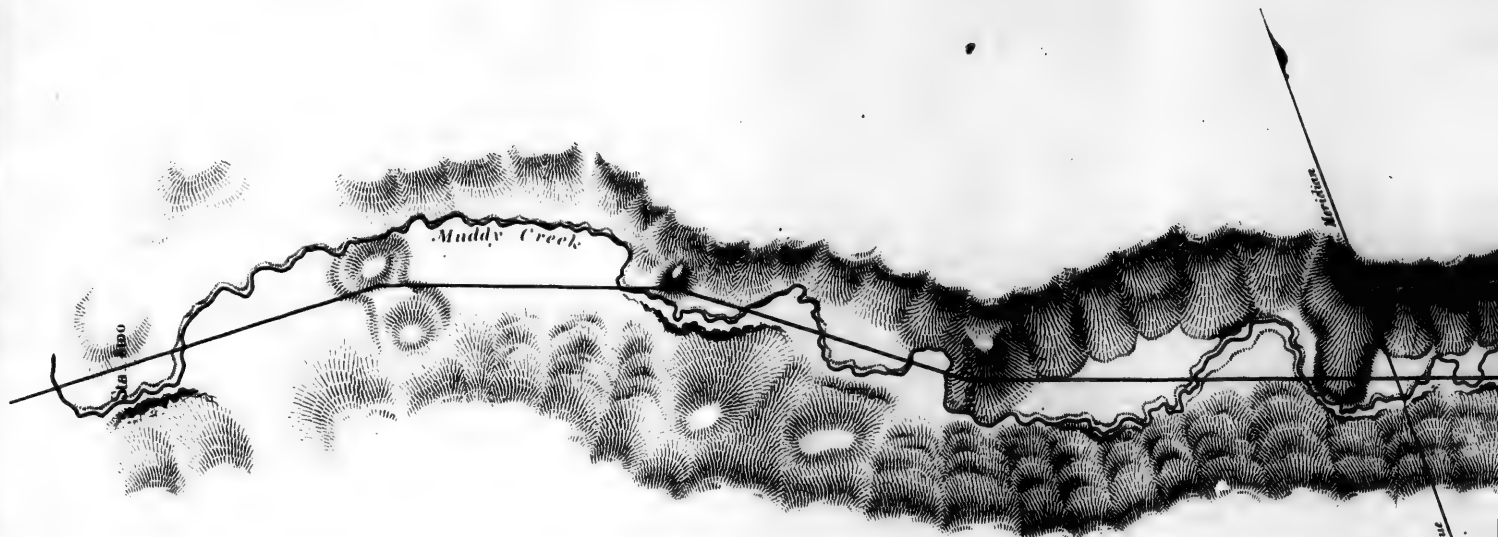
The distance from the broad dividing ridge at the head of this stream to its junction with Green River, is 79 miles by our line, which keeps the valley for the entire distance with one exception, where we cut off a bend the stream makes to the northward, saving a distance of four miles at a very slight sacrifice of grade and profile.

The extreme scarcity of herbage for our stock made it neces-

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UNION PACIFIC RAIL ROAD
 SURVEY OF 1861
 JAMES A. EVANS DIV. ENG.
 UPPER CAÑON OF MUDDY CREEK

SCALE 800 FEET TO AN INCH.
 The Map is Knapp, Eng. & Latta's 449 Broadway N.Y.

By the Union Pacific R.R. Co. over the Union



PACIFIC RAIL ROAD

VEY OF 1861
EVANS DIV. ENG^r

OF MUDDY CREEK

100 FEET TO AN INCH.

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sary to push over this part of the line with great rapidity. Extraordinary exertions were made by the party to reach Green River at the earliest possible time compatible with the interests of the survey. When I state that runs of 12 miles per day were made over this portion of the line, engineers will understand the anxiety manifested by those engaged in the work. The favorable nature of the surface (affording no choice of ground but that could be readily detected by the eye) enabled us to reach our terminus at Green River, in nine working days from the time we first touched the drainage of Bitter Creek. The profile shows very light work until we approach to within six miles of Green River. It seems to be a characteristic feature of this region that stream form their intersection by means of narrow gorges, Bitter Creek is no exception; the last six miles of its course is through a crooked cañon, the sides of which are composed of friable sandstone and shale.

Having understood that Mr. Reed, in charge of the party west of Green River, made his connection near Rock Springs, some 18 miles above the mouth of Bitter Creek, it does not seem necessary to be minute in description of that part of the line.

TIMBER—FUEL—COAL.

From what has been already said in the first part of this report in reference to the supply of timber for the line east of the Black Hills, viz.: the valley of Lodge-Pole Creek and the South Platte, it is evident that the surplus in the Black Hills and along the Medicine Bow Mountains, will have to be made available to supply the almost entire want of so important an item of construction on that part of the route. From Julesburg, on the South Platte, to Camp Walbach, at the foot of the mountains, is 175 miles. This distance will require 394,000 cross-ties alone. As the building of the road will probably be from east to west, this material will have to be furnished in advance of construction, by teams.

The superior direction, and consequent saving of distance from the Missouri River to Salt Lake City, via Lodge-Pole Creek Cheyenne Pass, Fort Halleck, and Bitter Creek, over the much

longer road, via the North Fork of the Platte, and the South Pass, is fast diverting the travel to the former.

During the past season a large proportion of the emigration has travelled it in preference to the latter and older route. It is believed the Lodge Pole road will continue to grow in favor. By establishing proper and convenient places of deposit for ties along the Lodge Pole Creek, much, and perhaps all this hauling could be done by empty return trains from Salt Lake. The mode of supplying the desert country on this division west of Rattlesnake Pass with fuel (wood, ties, timber for bridges, &c., is obvious.

COAL.

The first indication of this mineral in place on the line occurs on Rock or Frappe's Creek, in Latitude $41^{\circ} 43'$.

On the other side of the divide, near the Medicine Bow River, at station 3640 of our line, a seam of coal can be seen two feet thick, dipping south southeast, at an angle of 20 degrees. The coal is inferior in quality, being extremely dry and brittle.

East of Fort Halleck, coal is again found, probably of the same formation. At both of the places mentioned, some mining has been done, the coal from each having been used for blacksmith purposes with success. As to the extent of the deposit east of the North Platte River, the undersigned has no means of basing an intelligent opinion. It may be stated, however, that the places mentioned are not the only ones where coal is found east and north of the Medicine Bow Mountains. The next coal found is near Sulphur Springs stage station of the Overland Stage Co., on Muddy Creek, 14 miles west of the summit of Bridger's Pass. It is seen at the mouth of the cañon, at a considerable elevation above the stream, and gives the following section.



This opening has been worked systematically, and is carried in a distance of 40 feet, with but little appreciation in the quality of the coal, it being like that found to the eastward, brittle and imperfectly mineralized. The station of the Overland Stage Company, at Sulphur Springs, is the headquarters of one of the divisions of their line; their blacksmith and repair shops are here. The object in making the coal opening, of which a section is given on the other side, was to save the hauling of coal from Bitter Creek, whence they procure their supply.

At the shop I found some good specimens from that locality. I afterwards visited the opening from which they were obtained, and a specimen is now in your possession; an analysis of it will probably be made. At Black Buttes, 30 miles from the summit of Bitter Creek, and on our line, where this coal occurs, several seams have been opened, one 5 feet, and one $3\frac{1}{2}$ feet of clean coal. Frequent propping is required, in consequence of the broken, fragmentary nature of the roof. This is the hardest and best quality of coal found on the line. It may be stated that these are merely surface openings—other seams may occur at a greater depth; if so, they will be found of a superior quality, having a better roof. Some expenditure in sinking shafts will probably be necessary to determine fully the extent and value of this coal basin. As far as my examination and observation went, from this point (Black Buttes) to near Green River, the coal crops out of the bluffs frequently, and seems abundant.

Approximate Estimate of Quantities.

MASSORY.

Reference to Profiles.	From Station.	To Station.	Miles.	Cubic yards earth excavation.	Cubic yards solid rock.	Cubic yards tunneling.	Cubic yards rock culvert.	Cubic yards arch culvert.	Cubic yards bridge abutts and piers.	Timber in trestles and foundations.	Linear feet truss bridging.
Black Hills.....	0	1230	23.29	12,100	804,700	14,000	1,171	3,012	1,107	2,800 ft. F.M.	600 feet.
Laramie Plains, No. 1.....	1230	2770	22.11	355,406	24,000		183		225	1,700 "	300 "
" " 2.....	2770	3660	16.56	375,312	120,274		365	538	178	5,000 "	290 "
Laramie P. & Rattlesnake Pass.....	3660	6520	35.21	478,160	208,462		478	586	184	5,000 "	600 "
Platte Valley & Saige Creek.....	5520	7370	35.04	438,390			423	184	1,088	8,000 "	
Wrighter's Pass & Muddy Creek.....	7370	9350	37.50	510,230	20,000		94	254	980	4,000 "	
Bit. Creek, No. 1.....	9350	10970	30.70	209,580					1,280	12,800 "	400 "
" " 2.....	10970	12950	37.50	366,780	96,280				1,840	13,400 "	800 "
" " 3.....	12950	Green River.	24.48	267,890						14,500 "	
Total.....			269.69	3,008,778	1,270,716	14,000	2,694	4,464	7,640	67,100 "	2,980 ft.

Average for 1 mile.....11.156 4,712 51 1/2 9 1/2 16 1/2 28 1/2 248 ft. 11 1/2 ft.

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It may be proper to state here, that no temporary structures are contemplated in the foregoing estimate. In all cases, even when there is a want of material, and where no located line would balance the excavation and embankment, the estimate has been made under the supposition that material would be borrowed for the purpose of making the fills. This has been done for the purpose of simplifying the estimate, and affording a basis to work from, in arriving at the cost of construction. The Black Hills are peculiar, in that the principal ravines on either slope are deep and narrow, with no ridges between, making it difficult obtaining the material necessary to fill them from the adjacent cuttings. On this part of the line the material is all rock. It is a question to what extent truss bridges or short viaducts may be used with advantage and economy. The crossing of Lodge Pole Creek, on the eastern slope, a type of all of them, would compare in quantities, as follows:

1st. Estimate for full embankment, cubic yds.	60,920
Arch culvert masonry "	810
2d. Estimate for truss bridge:	
Embankment, "	12,360
Masonry in piers and abutments, "	1,856
Truss bridging, lin. feet.	300

BRIDGING.

	Lin. Feet.
Main Fork, Laramie River.	350
Left hand Fork, Laramie River.	250
Cooper Creek.	50
Rock, or Frappe's Creek.	250
Bear Creek.	50
Medicine Bow River.	150
Pass Creek.	80
North Platte River.	600
Bitter Creek, 17 crossings.	850
Green River.	350
Total.	2,980

MR. EVANS' REPORT.

TABLE OF GRADES.—ASCENDING.

DISTANCE.		Grade per 100 feet.	Grade per mile.
Feet.	Miles.		
7,000	1.325	2.8	147.84
43,700	8.278	2.2	116.16
44,400	8.409	2.0	105.6
7,600	1.439	1.9	100.32
16,800	3.143	1.8	95.04
22,500	4.240	1.6	84.48
42,500	8.049	1.5	79.20
37,700	7.140	1.2	63.36
30,700	5.814	1.0	52.80
83,000	15.719	0.8	42.24
94,400	17.878	0.5	26.40
34,400	6.515	0.3	15.84
82,400	6.136	0.2	10.56
46,900	8.880	0.1	5.28
Total....		102,963....Miles.	

TABLE OF GRADES.—DESCENDING.

DISTANCE.		Grade per 100 feet.	Grade per mile.
Feet.	Miles.		
56,000	10.606	2.5	132.09
48,100	9.110	2.2	116.16
34,600	6.563	2.0	105.6
8,600	1.628	1.9	100.32
4,800	0.909	1.8	95.04
14,200	2.689	1.6	84.48
39,600	7.5	1.5	79.20
48,300	8.768	1.2	63.36
9,900	4.335	1.0	52.8
82,500	11.837	0.8	42.24
91,200	17.84	0.5	26.4
58,900	11.155	0.3	15.84
59,900	11.344	0.2	10.56
161,800	30.648	0.1	5.28
Total...		134.917....Miles.	

Distance ascending..... 102.963
 " descending..... 134.917
 " level..... 31.81
 Total distance..... 269.69

TABLE OF ALIGNMENT.

$\frac{1}{2}^\circ$	1°	$1\frac{1}{2}^\circ$	2°	$2\frac{1}{2}^\circ$	3°	$3\frac{1}{2}^\circ$	4°	5°	$5\frac{1}{2}^\circ$	6°	8°
Rad.	Rad.	Rad.	Rad.	Rad.	Rad.	Rad.	Rad.	Rad.	Rad.	Rad.	Rad.
11,459 feet.	5,730 ft.	3,890 ft.	2,865 ft.	2,292 ft.	1,910 ft.	1,637 ft.	1,433 ft.	1,146 ft.	1,042 ft.	955 ft.	716 ft.
1.05 miles.	24.89 m.	1.06 m.	6.12 m.	1.17 m.	22.23 m.	1.42 m.	6.13 m.	5.45 m.	0.28 m.	3.38 m.	1.49 m.
											Tangent 195.02 miles.

Tangent..... 72.31 per cent.
 Curve..... 27.69 " "

Length of Tangent line..... 195.02 miles,
 " Curve " 74.67 "

Total length of Division..... 269.69 "

TABLE.

	Latitude.	Longitude.	Altitude, Feet.
Camp Walbach.....	41° 18'	105° 15'	7,000
Summit of Black Hills.....	41° 16'	105° 29' 48"	8,656
Crossing of Main Fork of Laramie...	41° 16' 17"	105° 34' 18"	7,175
Rattlesnake Pass.....	41° 45'	106° 39' 12"	7,560
Crossing of North Platte River.....	41° 42' 20"	106° 59' 45"	6,695
Bridger's Pass.....	41° 41' 09"	107° 30' 48"	7,534
Head of Bitter Creek.....	41° 31' 56"	108° 16' 48"	7,090
Green River.....	41° 32' 51"	109° 30' 20"	6,092

REMARKS.

Soon after crossing the Black Hills with my line, I was impressed with the necessity of making a further examination of that range of mountains, both to the northward and likewise to the southward of the ground covered by my instructions; I should have done so then but for the following consideration: As stated before, my work was largely increased and extended in consequence of the non-acceptance of one of the appointments. I looked upon the necessity of having a line through as of the first importance. In accordance with that supposition, I resolved to push my line to Green River, for the purpose of making my connection there, then, if time permitted, to return to the Black Hills for further examination.

The country west of the North Platte River proving much more favorable than was anticipated, enabled the party to reach the terminus on the 26th July. On the following day (27th) we started on our return journey.

I expected, if time permitted, on my return, to examine the country south of our main line over the Black Hills (the range being considerably less in elevation there), if possible avoiding the drainage of Crow Creek, and finally reaching Lodge Pole Creek by means of a tributary of that stream (south of the main branch which we followed on the eastern slope), and designated on the maps as Muddy Creek. After that was done, it was my purpose to examine the Cañon of the Laramie River, supposing that if

the latter afforded but ordinary obstacles to construction, the question of grades there would be an easy one, running, as this river does, completely through the range.

On reaching Fort Halleck, on my way back to this work, I found instructions requiring me, if possible, and if the state of my supplies warranted me in so doing, to return by way of the South Pass.

To make this part of my report intelligible, it becomes necessary to state here, that Fort Halleck was fixed upon as our base of supplies, and for obvious reasons, among which may be stated its central position with reference to the division, and the superior facilities it afforded for storage.

In pushing our line west, we left Fort Halleck with rations sufficient to take us to Green River and back to the fort. When we reached there on our return our stock of provisions required replenishing.

Had my instructions, therefore, found me at Green River instead of Fort Halleck, it would not have been possible to have complied with them.

I regard it as unfortunate that the possibility of our being able to return by way of the South Pass was not foreseen and provided for, and a different arrangement of supplies made to meet the emergency, as it would have enabled me to have based upon actual observation, what is now but conjecture and the observation of others.

When we left Omaha, the impression prevailed that the extent of the division would prove to be all one corps could accomplish during the season.

As stated before, the favorable nature of the ground, the fortunate proximity of the travelled road to our line, enabling us to move our transportation readily and with despatch, combined with the strength and efficiency of the party, brought us to our terminus at least six weeks earlier than I anticipated.

The geographical position of Fort Halleck with reference to the South Pass will show the difficulty in reaching the latter.

Had our supplies been in shape it is very questionable if the integrity of the party could have been preserved. The ordeal our stock had passed through west of the North Platte River, made our teamsters extremely reluctant to traverse a similar

Altitude,
Feet.

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region still more extensive. That reluctance (had the order been given to retrace our journey) would have resulted in insubordination, and other and different arrangements for transportation would have become necessary. This I should not have hesitated about, however, had it been the only difficulty in the way.

Here Mr. Finney, first assistant, left the party and returned to the States.

I concluded, however, that I would carry out the programme I had already marked out, with reference to the head of Crow Creek and the Laramie Cañon; then, if rapid transportation and escort were provided me through the military authorities at Fort Laramie, I would go to the South Pass, taking with me a few men, for the purpose of examining the salient points on that line, the party returning to the Missouri meanwhile.

The result of our labors in the Black Hills, south of our main line, may be summed up thus: The starting point (running back) of the branch line is a little west of our crossing of the main fork of Laramie River. Distance from the point of divergence to the foot of the range by main line $5\frac{1}{2}$ miles, by branch line 9 miles, caused by the latter striking the range more diagonally. The broken nature of the surface after touching the Black Hills, had the effect of keeping us constantly at the foot of the slope. When it became necessary to turn to the left for the purpose of preserving our direction and to prevent our being thrown into the tributaries of Crow Creek, the elevation was found to be greater than we could surmount.

Explorations have been made since on the Cache-la-Poudre Creek, in the country to which this line would have carried us, had we continued it, and is probably the line with which Mr. Case connected his survey.

It must be understood here, that our labors were done with a view of still making the valley of Lodge Pole Creek our eastern continuation.

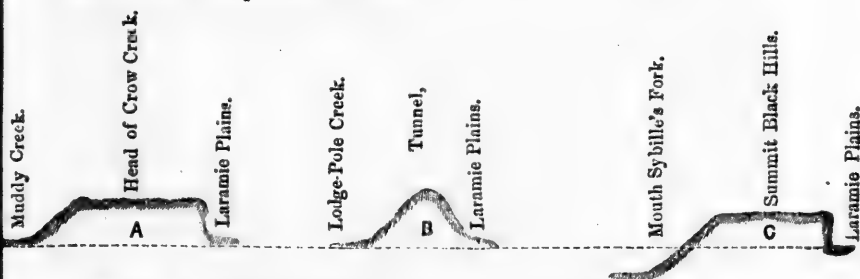
Our journey to the Laramie Cañon was by way of Camp Walbach and the Valley of the Chugwater to near its mouth, where we crossed a low divide between it and the Laramie River; thence up the latter to near the mouth of Sibylle's Fork,

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where we established a camp, intending to devote some time to an exploration of the hills in that vicinity, the Cañon of the Laramie and the Valley of Sibylle's Fork. On producing a line 25 miles up the latter, we found it did not penetrate the range with anything like a distinct valley, besides carrying us far to the southward. My explorations and observation now enable me to form an idea of the several crossings of the Black Hills. The sections will compare as follows:



Section A.—From Muddy Creek to Laramie Plains.

B.—Section on main line.

C.—Sybille's Fork to Laramie Plains.

It will be seen that both the sections A and C are lower than the crossing of our main line. What constitutes their inferiority is the great rapidity of the descent where it does occur. The Laramie Cañon remains to be noticed.

I approached this part of my labor in the mountains with no little interest and solicitude. As our main line progressed across the North Platte River, over Bridger's Pass, and over the country between Muddy Creek and Bitter Creek, a sufficient knowledge of the country north was obtained to show the feasibility of a line, striking the Medicine Bow River at its elbow, the North Platte below the mouth of Pass Creek, then north of Bridger's Pass, and by means of some one of the valleys leading into Bitter Creek from the northeast, forming a junction with our line in the valley of that stream.

The Laramie Cañon seemed to be the key to this route.

It will be understood, then, that the importance of this gorge was not underestimated by me—no information could be obtained as to its character, even from mountain men, supposed to

be familiar with all the nooks and gorges of a country in which they had spent the whole of their manhood, and no small part on of their declining years. While camped within a mile of its terrible chasm, projecting points obscured it so entirely from view, that had it not been for the river rushing by our tents and the previous knowledge of its existence, it might have been passed unnoticed.

Taking with me Messrs. Dutton, Sladden, O'Neil, and Booze, of the party, I started from camp 74 on the morning of August 30, with the intention of tracing the river through the gorge. It is unnecessary to detail the difficulties we encountered in proceeding up it on merely a prospecting tour.

The river has evidently cut its way through the range, composed principally of granite and gneiss; its channel is extremely crooked, hemmed in closely by (for the greater part of the distance) vertical walls of rock, ranging in height from 500 to 1,500 feet—what room there is is occupied solely and exclusively by the bed of the torrent. Where it cuts through the cone of the range it forms a succession of rapids for miles, descending, it is estimated, from 3 to 5 feet in 100; these rapids would form a great obstacle, were the sides of the gorge otherwise favorable and the curvature such as could be overcome. From the necessity of keeping close to the water, (as where the walls are not vertical, the talus, at the foot is insignificant, and by no means continuous,) it will be seen that the grade would have to undulate with the descent of the stream, and no advantage could be taken of distance to overcome *extraordinary* elevation at any one point. In overcoming a distance of 12 miles in a direct line, this river must run through 22 miles at least of cañon. For a portion of the distance it more than doubles itself. Two cases were noticed, particularly where the stream is only prevented from forming a perfect ellipse, by a vertical wall of gneiss 1,000 feet high and 700 feet through from water to water. The cases above were noticed as extraordinary, but the whole distance is a succession of short bends, many of them forming greater obstacles still to the construction of a line. A succession of tunnels and bridges would be required for almost the entire distance. Taking this view of it, I did not think it necessary to run any line up it. It seemed now that we had, either by actual trial or observation



J. A. EVANS. DIV. ENG. U. P. R. R. DEL.

LITH. OF MAJOR & KNAPP, 400 BROADWAY, N. Y.

UNION PACIFIC RAIL ROAD

SURVEY OF 1864.

CAÑON OF LARAMIE RIVER.

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examined everything within accessible distance that promised an opening.

On the 1st September, I started for the eastward with the party, expecting, when I reached Fort Laramie to learn by telegraph, something to govern my future operations.

At Fort Laramie I telegraphed for instructions. The reply was, in effect a permission to send the party back, and a request to go the South Pass myself for the purpose of observation.

In accordance with, and from a strong desire to comply with the request, as well as a wish on my own part to be in possession of facts necessary to institute a comparison between routes that seemed likely to come into competition, I started the party from Fort Laramie for the Missouri River, on the 5th September, remaining myself, with the intention of going up the North Platte for the purpose mentioned.

My only reliance for transportation, rations, &c., being on the ability and courtesy of the commanders of the different military posts, no arrangements having been made through the commander of the district.

The Indian difficulties having their origin in the spring, had increased intensely, until during the summer, the whole frontier (including the valley of the North and South Platte) was rendered insecure. At the time of my arrival at Fort Laramie, the several posts along the North Platte River, from Fort Laramie to the South Pass, were considered in danger. It is certain they were but feebly garrisoned, and incapable of offering anything like a protracted defence. This feeling of insecurity, coupled with the difficulty of procuring transportation and the consciousness of being so entirely subject to the movements of others, forced me reluctantly to the conclusion that I could not do what I desired with the requisite despatch, if at all. I, therefore, left the post with the purpose of overtaking my party, which was done on the following day.

Our return was along the telegraph road, striking our outward line of travel on the Lodge Pole Creek, 40 miles above its mouth.

By the exercise of constant vigilance, through a country from which the inhabitants had been forced to flee, and where the savages were decidedly hostile, we safely reached Omaha, with but slight interruption, on the 25th day of September.

It may be deemed a subject of congratulation that we returned without the loss of a single member of the party, with our stock entire, and everything in good order.

CONCLUSION.

By using the accompanying table of latitude and longitude in connection with a map of the country, it will be seen that in point of direction, the line of which this report is descriptive, stands pre-eminent. Taking the junction of the North and South forks of the Platte River, as a common starting point, the distance by way of Fort Laramie, through Valley of the Sweetwater, and through South Pass, would, under the most favorable circumstances, be increased 70 miles over this line.

In addition to the above, the Bridger's Pass route affords a much larger amount of valuable timber contiguous to it, than the line by the South Pass. A very important consideration, and one by no means to be overlooked.

Coal is said to occur on the North Platte, above Fort Laramie, as well as on Bitter Creek; both of these coal deposits should receive the closest scrutiny before any route is finally decided upon. My opinion is, and I give it with diffidence, that the result of such investigation will be to entitle the route *via* Bridger's Pass to still greater consideration. From some little observation of the valley of the North Platte, near Fort Laramie, from hearsay, and from the profiles of military engineers, I am led to believe that the upper route is by no means one of continuously ascending and easy grades, as far as South Pass, even. In some instances it will be found necessary to leave the valley of the stream on account of cañons and narrows.

Some distance below Fort Laramie the North Platte ceases to be a river of the plains.

Twenty-five miles above that military post, it runs through what is called Horseshoe Cañon. Here spurs of the Black Hills extend some distance to the eastward and across the river. Major Bridger, in a conversation I had with him at Laramie, was very emphatic in stating that no line could pass up it. The alternative, in his opinion, was to have the valley of the river below the Fort, follow up the Rawhide Creek, striking

the Platte again at or nearly opposite the mouth of La Bonté Creek. This would be leaving the valley of the Platte for a distance of 45 miles.

I do not mean to be understood that there is anything insurmountable here; only to show some of the obstacles that may be expected on this route, not only at the Horseshoe Cañon, but at Red Buttes, still further up, at the mouth of the Sweetwater, and at Devil's Gate, on the latter stream.

As the South Pass route will probably be examined, it does not seem necessary for me to follow the comparison further. I have merely given what information I was able to obtain.

I cannot close this communication without making one or two suggestions for the benefit of the Company in future explorations, as conducing to the efficiency of parties in the field, as well as the comfort mentally of those who may have charge in conducting the surveys.

There is no probability that the Indians will be more peaceable during the coming season that they have been during the one just past. Parties of engineers going there, unless protected by escort, will be subject to interruption and delay, if nothing more. The efficiency of the escort depends in a great degree upon the ability and attention to duty of the officers temporarily in command. My suggestion is, that the engineer in charge of the party should, by means of some arrangement with the War Department, be able for ~~the~~ time being, to outrank the commander of the escort. By no other means can unity be preserved and a conflict of authority prevented.

The other suggestion is, that either the Company, or head of the party should *absolutely own* the means of transportation. We suffered no inconvenience in consequence of this defect in our organization, but I can now see, how easily contingencies might have arisen, making it necessary to remodel this part of the organization of the party—a thing difficult of accomplishment in the Rocky Mountains.

In conclusion, I wish to acknowledge my obligations to the members of my party.

To F. N. Finney, 1st Assistant, I am particularly obliged for his valuable assistance so cheerfully rendered while he remained with the party.

From Messrs. Dutton, O'Neil, Furguson, and the remaining members of the corps, I received valuable assistance, for which they are not only entitled to my thanks, but to the consideration of the Company.

Praise is due Colonel W. O. Collins for his promptitude in furnishing escort.

To ——— Jones, Esq., now of Salt Lake City, then in charge of the sutler's establishment, at Fort Halleck, I am obliged for several acts of kindness, among which may be mentioned his liberality in furnishing us with room for storage without charge.

Respectfully submitted,

JAS. A. EVANS,
Div. Eng.

TO T. C. DURANT, Esq.,
Vice-Pres't, U. P. R. R. Co.,
13 William St., New York.

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APPENDIX B.

Report of F. M. CASE, *Division Engineer, on Surveys
of Cache La Poudre, and South Platte Routes; and
other Mountain Passes in Colorado, made in*
1864.

OMAHA, Neb. T'y, December 15, 1864.

Sir,—Under my instructions to gather, by actual survey and otherwise, whatever information I could relating to the mountain passes of Colorado, I have the honor to submit the following:

REPORT.

These passes, or such of them as have been spoken of as possible or practicable for railroad purposes, are the Caché La Poudre, the Boulder, the Berthoud, a pass at the head of the North Fork of the South Platte, one at the head of Tarryall Creek, and the Hoosier Pass near Montgomery.

THE BOULDER PASS.

From information obtained from Mr. D. C. Collier, a very intelligent explorer of Colorado, and now editor of the *Miner's Register*, of Central City, and from other sources, I judge the Pass to be at least 11,900 feet above the level of the sea. The

valley (of S. Boulder) at the foot of the mountains cannot be more than 5,600 feet. The elevation of Boulder City, six miles' north, on North Boulder, being 5,536 feet. This leaves a difference of elevation of 6,300 feet, and this elevation must be overcome in a distance at most of 35 miles. Knowing these facts, I have not even visited the Boulder Pass.

THE ROUTE UP THE NORTH FORK OF THE SOUTH PLATTE

Would enter the mountains at the cañon of the South Platte, follow up that stream about ten miles to the mouth of the North Fork, thence up that stream 35 miles to the range, and thence connect with one of the heads of Snake River, an affluent of the Blue. The pass is represented by Hon. Daniel Witter, another very intelligent explorer of Colorado, as being a little below the "timber line," probably about 11,500 feet above tide-water. From elevations kindly furnished me by Dr. C. C. Parry, I am enabled to give some information that may be of use in judging of this route. At a point 12 or 15 miles below the pass ("The Forks,") the elevation is 9,153 feet, at 7 miles below it is 8,405, and at a point 4 miles further down 8,018, indicating that a practical grade would follow the valley to "The Forks." The trouble I apprehended would be to overcome 2,300 feet elevation in the 12 or 15 miles from that point to the pass, without a very long tunnel.

The descent upon the western slope to the mouth of Snake River, a distance of not more than 20 miles, is 2,700 feet, upon the hypothesis that the pass is 11,500 feet above tide-water. The route for the entire distance from the plains to the Blue is through a narrow valley, and in many places doubtless very tortuous.

THE TARRYALL CREEK ROUTE

Enters the mountains *via* South Platte, and follows up the main stream 10 or 12 miles further than the last mentioned route, where it diverges, following up the valley of Tarryall Creek some 25 miles to the South Park, thence near the creek across the Park to Hamilton and Tarryall, thence up the main stream to



DELINATED BY F.M. CASE, DIV. ENG. UNION PACIFIC RAILROAD.

ENTRANCE OF UPPER CANYON OF SOUTHERN PLATE.

Sept. 16, 1864.

LITH. OF MAJOR V. W. APP. & BROS. N.Y.

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a pass about the height of Hoosier Pass, from which it descends Indiana Gulch to the Blue above Breckenridge.

Of this route I can say but little advisedly. Dr. Parry gives the elevation of Tarryall (old town) at 9,932 feet. The pass, at a distance, in my opinion, not exceeding six miles, is 1,500 feet higher. I do not think that the maximum grade allowed by the charter would go within two miles of the pass, following the stream. Whether there is any way of making distance on this approach or not I cannot tell, as I have not had an opportunity of examining the route from Tarryall to the pass. I have been down Indiana Gulch to the Blue, and should say the descent was 150 or 200 feet to the mile.

THE SOUTH PLATTE ROUTE.

I have made a partial survey of this route, and report herewith a profile of Hoosier Pass, a profile of a line 18 miles down the Blue, and one of a line 48 miles down the South Platte, through the South Park to the head of the cañon.

A tunnel of $2\frac{1}{2}$ miles in length would be required at the crossing of the range. This tunnel would be through granite the entire distance, and would doubtless cross several gold lodes, which crop out upon the western, or rather northern slope.

The line upon the western slope would have to follow the side of the mountain to get a practical grade. I should think distance sufficient could be gained upon the east side of the Blue to allow the grade to reach the valley a few miles below Breckenridge, from which point to the mouth of the Blue the line would follow a fine wide valley, with easy grades, as indicated by the profile, and good alignment; except that the valley makes but very little westing in its entire length.

A line down the South Platte may be located so as to secure, very nearly, a uniform grade from the mouth of the tunnel to the head of the cañon, where my line terminates, with light curves and light work, as the profile indicates.

When I reached the head of the cañon, I found, by examination, that it extended 9 or 10 miles, and there being no way of moving camp down the valley, except by "packing," I concluded

UNION PACIFIC RAIL ROAD
SURVEY OF 1864.
MOUTH OF CANON OF SOUTH PLATTE

The Majors Group Fine Arts Ltd. 6449 Broadway, 711

F. M. C.



R. M. CASE DIV. ENG'G DEL.

UNION PACIFIC RAIL ROAD
SURVEY OF 1864.
MOUTH OF CAÑON OF SOUTH PLATTE.

The Surveying Trip of the 1864 Survey of the Union Pacific Railroad.

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at Georgia Gulch, during the winter of 1861-2, I learned that the total fall of snow at that place was 37 feet; and in one storm in February, 1862, 11 feet. Georgia Gulch is on the western slope—one of the gulches of Swan River, an affluent of the Blue.

THE BERTHOUD PASS ROUTE.

I did not have time to make any further examination of this route the past season, and have but little information to report that is not contained in my report to Gov. Evans in 1862. Which report, with a few corrections, such as further experience in the geology and climatology of Colorado dictates, I here insert, that I may embody in one paper all the information I have been able to obtain upon the subject, up to the present date.

“COLORADO TERRITORY,
Denver, August 15th, 1862. }

“HON JOHN EVANS, Gov.
Col. Territory :

“Sir,—In submitting to you this report of my late instrumental reconnoissance of the Berthoud Pass and its eastern approach, with the view of its being laid by you before the Board of Corporators of the Pacific Railroad, I am aware that the facts which will be of real interest to practical railroad men are very meagre; yet, as many misrepresentations have been made upon mere opinion, the few facts I have gleaned may be of interest to the Board of Corporators, of which you are a member.

“I have had a connected line of levels run from the Platte River (at the upper bridge in Denver) to the summit of the Pass and two and three fourths miles down Moses Creek, on the Pacific slope. From one mile below Empire City a transit line has been run over the Pass—levels have been run up Clear Creek, a mile and a half above the mouth of Hoope's Creek, opposite the pass, and also from Empire City to the low pass between Bard Creek and the south fork of Clear Creek. Between this low pass and Georgetown, one and three fourths mile south, the relative elevations have been ascertained by barometric

observations, by Dr. Parry, a gentleman who is spending the summer near the Range, making scientific explorations.

"I submit herewith a map of the route from Denver, westward, embracing the Pass, giving a very fair representation of the topography of the country in the vicinity of the Pass, with the relative elevations at certain points, as ascertained by the levels. Upon this map I have drawn a proposed location of a railroad line, which, in my opinion, will be near the most practicable route for the real location. The length of the tunnel I make three and a half miles. I have made this length by supposing an up grade of fifty feet to the mile, running westward in the tunnel from the entrance, for two miles, and thence running a down grade of ten feet to the mile, to the exit.

"An up grade in the tunnel of one hundred feet to the mile for the first two miles, instead of fifty, would shorten the tunnel about one fourth of a mile. The grade, as you will notice, is less than 116 feet to the mile from the forks below Empire City to the tunnel, but the equation for curvature, on the line I have drawn, would probably bring the grade up to this maximum.

"This range of mountains, on its eastern slope being subject to a very considerably less fall of rain during the year than the Alleghanies or New England mountains, are much less disintegrated, and are fitly called "Rocky Mountains." The mountains on either side of the valley of Clear Creek are "rugged," with frequent points of rocks projecting into the valley; for this reason I have drawn the line so as to get down into the valley with the grade as soon as possible.

"I might say in this connection, that there would be a *possibility* of striking rich gold lodes in the construction of the tunnel, for it is in the "Gold Belt," there being lodes on each side of the pass, yet I would not like to undertake the construction of the tunnel with the understanding that I should take this "possibility" in "part pay."

"Of the Western approach to the Pass I will hazard no opinion as to gradients or courses. The Western slope of the Range seems to be covered with a much deeper soil, as it is covered with a much denser foliage, which is doubtless owing to the arrest and precipitation of the spring and summer rains by the snow of the Range; the prevailing winds being northwesterly.

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THE EXIT OF THE PLATTE FROM THE SOUTH PARK.

UNION PACIFIC RAIL ROAD

SURVEY OF 1864.



F.W. CASE, CIV. ENG. & SUE.

LITH. OF NEW YORK & NEW YORK
405 BROADWAY, N.Y.

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This fact, in case of having to keep the mountain sides to get down to the valley of the Grand River, would render the cost of construction much less than upon the Eastern Slope.

"I have made considerable inquiry as to the winter snows in the neighborhood of the Pass, and find that at Empire City, they have wintered cattle every winter without hay. From all the statements of settlers on the experience of three winters, I am of opinion that the winter snows would form no serious obstacle to the running of railroad trains from the tunnel eastward. About three-fourths of a mile from the Pass, on the western slope, we passed a camp where a family were snow-bound last winter, for some weeks, and judging from the height of the stumps of trees cut by them while there, should think the snow must have been five or six feet deep. This depth, from all the information I can glean, would be about a fair average for about fifteen or twenty miles west of the Range, in the vicinity of the Pass. The prevailing winds being from the northwest, the snow piles in immense drifts on the southeastern slopes of the range. These slopes, in the vicinity of the Pass, being very precipitous near the summit, arrest the snows before they reach the valley of Clear Creek. This fact may account for the light fall of snow near Empire City.

"The following table will show very nearly the distances between the points at which I have ascertained the elevations above the Platte at Denver, along the proposed route from Denver, westward to the Pass:

Places.	Distances.	Elevation.
Platte River, at Denver.....	.0 miles.	0.
Divide between Denver and Golden City..	7.5	" 544.
Golden City.....	5.0	" 500.
Ten miles up the Cañon.....	10.0	" 1580.
Where Idaho road enters valley of Clear Creek	6.8	" 2019.
Idaho	5.2	" 2395.
Forks of Clear Creek below Empire City.....	7.3	" 3117.
Georgetown.....	4.0	" 3519.
Entrance of Tunnel.....	13.0	" 4820.
Total distance from Denver.....		58.8 "

"In entering the Cañon of Clear Creek, either from Denver or the mouth of Clear Creek, the road can go into the Cañon from one to five hundred feet above the water of the creek, if a better line can be found at such elevation.

"Of the cost of construction of a railroad from Golden City to the entrance of the tunnel, I cannot, of course, make an estimate upon this reconnaissance, but should say the expense would not be greater than the average of eastern mountain roads for the same distance.

"Hoping these few facts may be of service to you and the Board of Corporators of the Pacific Railroad, I am,

"Very truly your obedient servant,

"FRANCIS M. CASE,

"*Civil Engineer.*"

Since writing the foregoing report I have obtained from Dr. Parry the elevation of the head of the Middle Park, about ten miles of the pass on the western slope, which is 8,949 feet, or 1,340 feet lower than the mouth of the proposed tunnel $7\frac{1}{4}$ miles above. The Hot Springs, on the Grand River, 20 miles farther down, he makes 7,546 feet, showing an average grade from the head of the Park to the Hot Springs of about 70 feet to the mile.

There is one difficulty that would be encountered upon this route not mentioned in the above report, and that is in the form of avalanches or glaciers, which occur occasionally at two different points near the foot of the pass, upon the mountain side south of Clear Creek. The mass of snow and ice which accumulates at the head of gulches at these points, loosening next to the mountain by the action of the water from the melting snows, sweeps down the mountain side with a velocity that carries everything before it. At the one above the mouth of Hoop's Creek, I saw trees and rubbish which had been driven before the avalanche across the creek, and four or five hundred feet up the northern slope of the valley. A located line would cross the track of both these avalanches.

THE CACHE-LA-POUDRE ROUTE.

Over this route I have run a preliminary line, commencing at



F. M. CASE, DEL.

The Mayor & Knapp Engr. & Lith. Co. 440 Broadway N.Y.

UNION PACIFIC RAIL ROAD

SURVEY OF 1864.

LOOKING OUT OF STONEWALL CANYON EAST.

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La Porte, and running as indicated by the red line upon the accompanying map, I connected with Mr. Evans' line at his station 1,360, near the crossing of Laramie River.

Being entirely unacquainted with the topography of the country along this route, I kept my lines in the valley of streams until I passed Cherokee station, and thence along what appeared at first sight to be the most feasible route. My party being short I was obliged to be with them so much that I could not devote as much time to reconnoissance as I otherwise would. I very much regret that I had not time to run a new line nearly or quite the whole distance from La Porte to the summit; and also to try a line over the divide to the head waters of Crow Creek. I think I can get a fair line with lighter grades from La Porte to the Laramie Plains than are shown by any line yet surveyed over the Black Hills. Yet this is only my opinion. An actual survey only will determine this point. Some points are already settled by the present survey. One is, that Antelope Pass is 593 feet lower than the summit made upon the Cheyenne Pass route. Another is, that the descent to the Laramie Plains from Antelope Pass may be made with a grade not much, if any, exceeding 80 feet per mile.

I have indicated by a red dotted line upon the map, my proposed location. I think a line may be obtained with a practical grade by keeping in a valley to the right of the stage road, and coming into the road, or near it, above Boner station. If so, it would be very much preferable to any line following the Cache La Poudre and Dale Creeks. For those valleys being so narrow the grade must of necessity, be laid at least 25 feet above the bed of the stream. Evidences of the flood of last spring show that the water was 20 feet above its present stage.

If this route should be found to be impracticable, I would try a route as indicated by the westerly dotted line passing over (or rather going through with a thousand feet tunnel) a low pass, about opposite the junction of Dale and Cache La Poudre Creeks, and keeping along the eastern slope of the valley of Dale Creek, join the other line near the crossing of Stonewall Creek. From this point, I think, by keeping up the divide west of this creek, the line would enter Stonewall Cañon at a height sufficient to get a fair line through the cañon, and reach an elevation at its head

which would admit of getting up the divide beyond and near the stage road with a grade not exceeding 2.2 feet per station.

Much time and care should be bestowed upon a located line, as the country, especially from Poison Creek to the pass, is very rough, broken by points and ledges of granite thrown up promiscuously. In some places you see only bare and isolated peaks, in others, ledges, trending in every conceivable direction.

In this connection allow me to suggest that a thorough examination should be made of the divide, east of Dale Creek, and a few miles north of Virginia Dale, at the heads of Crow Creek and Box Elder. From what information I can get, the foot of the mountains east of this point is as high, or even higher than the starting point of Mr. Evans' line. That point is 1,953 feet higher than my starting point at La Porte. Now, if by some branch of Crow Creek or Howard's Fork, we can find a uniform grade to the summit, I think such grade will be within the limit fixed by the charter of the road. By reference to the map you will see that such a route would connect with a line up the South Platte, with a much better general alignment than by La Porte; or would connect with the Lodge Pole Route, by way of Muddy Fork, without a serious sacrifice of alignment. [See also Stansbury's Report, p. 258, *et seq.*]

If a route can be obtained up the valley, east of Boner station near the line I have drawn, it would pass over, from La Porte to Stonewall Cañon, soil that is underlaid by stratified rocks, with occasional outcrops of the latter. From Stonewall Cañon to Laramie Plains, the formation is all primitive; most of the way however, the surface is covered with a soil—the result of the disintegration and decomposition of the granitic rocks. In the Stonewall Cañon the granite is close grained, hard, and intersected by veins, or dykes of some basaltic rock. Toward the Laramie Plains, the feldspar predominates, rendering the rock more friable, and susceptible to disintegrating agencies.

As far as my observation extended, the primitive formation along the route shows no traces of any mineral veins whatever. My second assistant, Mr. Pim, says there is no doubt that Rock Creek, further west, comes down from a gold region. That he has seen the evidences himself; and also assured me that there



DELINEATED BY F. M. CASE DIV ENG^g UNION PACIFIC RAILROAD

LITH OF MAJOR & KNAPP, 448 BROADWAY, N. Y.

IN THE STONEWALL CAÑON.

Oct. 8th 1864.

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was a large body of iron ore in the vicinity of our line, (he would not say where,) that he had also seen himself.

I did not see any indications of coal, in the latter formations along the route. I did not look for them in the vicinity of the primitive rocks, believing that coal will not be found in such localities. The intense heat, at some period of their geological history, having driven off, or consumed the carbon, if it were ever there.

There is a sparse growth of timber, in places along the route, mostly a dwarfed variety of vine. South of the line, and at no great distance, appears to be a heavy growth of good timber.

I think there would be little difficulty in rafting timber down the Cache La Poudre, and less still in getting it down the Big Laramie.

Accompanying this report I have the honor to submit condensed profiles of the Cache La Poudre, the Berthoud, and the South Platte routes. These profiles are made from my own surveys, and from such other data as I have been able to obtain. The grades in these profiles are broken to show the general undulations of the surface only. I also submit maps of the lines run during the past season, together with a map of Colorado, showing approximately, all the different routes.

I have made no estimate of quantites upon any of these routes, for the reason that as yet I have not had time to run a line approximating the best location sufficiently near to make an estimate upon.

Respectfully submitted,

FRANCIS M. CASE.

Div. Eng'r.

To T. C. DURANT, Esq.,

Vice-Pres. U. P. R. R. Co.

No. 13 William St., New York.

DEMINATED BY F. M. CASE DIV. ENG. UNION PACIFIC RAIL ROAD

STONEWALL CAÑON, FROM A POINT $\frac{1}{4}$ MILE BELOW.

Oct. 9th 1864

LITH. OF MAJOR A. KNAPP'S DRAWING, N.Y.



DELIMITED BY E. M. CASE DIV. ENG. UNION PACIFIC RAILROAD

STONEWALL CANYON, FROM A POINT $\frac{1}{4}$ MILE BELOW.

Oct. 9th 1864.

LITH. OF MAPLE & KIMBLE'S PHOTOGRAPHY, N.Y.

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APPENDIX C.

*Report of SAMUEL B. REED, Division Engineer, on
Surveys and Explorations from Green River
to Great Salt Lake City, made in
1864.*

JOLIET, Illinois, Dec. 24, 1864.

SIR,—According to instructions, dated March 7th, 1864, I have the pleasure of submitting the following report of my explorations and surveys in the mountains east of and in the vicinity of Great Salt Lake City :

On reporting in Omaha, Nebraska, the 2d day of April last, I found that arrangements were not made for me to leave immediately for Great Salt Lake City.

While in Omaha, information was received that the First Assistant assigned to my party declined the appointment—Mr. A. J. Mathewson was transferred to fill the vacancy.

Arrangements for our journey being completed, we left Omaha, April 30th, *via* Western Stage Company's line, for Atchison, Kansas, where we were delayed until the 7th of May, before we could secure our seats in the Overland Stage for Great Salt Lake City.

I was informed that Governor Brigham Young would furnish all my men, teams and supplies for the survey.

When I arrived in Great Salt Lake City, he was absent on a tour to Bear Lake Valley, in the northern part of the territory

His absence caused a few days delay, however arrangements were soon made, and we commenced field work the first day of June last.

GREAT SALT LAKE CITY TO THE MOUTH OF WEBER CAÑON.

The point of commencement is in the northwest part of the city, near Jordan River, which is connected by courses and distances with the monument at the southeast corner of Temple Block, in north latitude $40^{\circ} 45' 44''$, west longitude $112^{\circ} 06' 08''$. The altitude of the beginning of the line, as shown on the profile is $4,285\frac{8}{10}$ feet above the sea.

From the point of commencement the line runs near the base of the mountains, in a northerly direction, past Warm and Hot Springs, and in the vicinity of the Great Salt Lake, to the mouth of Weber Cañon, a distance of $36\frac{1}{2}$ miles.

By referring to the map and profile, you will observe, that five or six miles of this distance can be saved by making a short tunnel through the low hills near the base of the mountains.

Careful surveys and estimates will determine between the line run and the one suggested. The amount of excavation and bridging on this portion of the line is light, grades easy, and alignment good.

The altitude at the mouth of the Weber Cañon, is 4,655.5 above the sea.

WEBER CAÑON.

On arriving at the mouth of this cañon we found it to be very narrow. The general course is direct. The sides of the cañon slope back at an angle which will admit of the road bed being made on the slope when necessary.

The river at the mouth of the cañon is 120 feet wide, and from four to six feet deep, being swollen at the time of the survey by melting of snow on the mountains. It has a strong, powerful current over a bed of water-worn stones, and fallen rocks of immense size.

There is one obstacle to be overcome in this narrow gorge, known as the Devil's Gate.

A heavy point projects from the south into the valley. This deflects the river 600 feet north of its general direction. The water rushes around this bend with tremendous force, where it is impossible to build the road on account of the short crooks, and the rapid fall in the river.

WASATCH PLATEAU AND RANGE FROM CAMP NO. 70.

JORDAN R. CAÑON AT NARROWS.

SURVEY OF 1864.

UNION PACIFIC RAIL ROAD

TWIN PEAKS

U.S. GEOLOGICAL SURVEY, A. J. MORTIMER, CORP., DEL.

1000 FT. HIGHER & HIGHER - NO BROADWAY, N.Y.

UNION PACIFIC RAIL ROAD

SURVEY OF 1864.

JORDAN R. CAÑON AT NARROWS.

WASATCH PEAKS AND RANGE FROM CAMP NO. 70.



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To overcome this obstruction $1\frac{1}{2}$ miles of maximum grade (116 feet per mile) will be required.

The line below the *Gate* winds along the side of the cañon, crossing ravines and projecting points of rock. From the *Gate* to the head of the gorge no heavy work is encountered.

The excavation through the cañon will be loose or solid rock. Granite and gniess predominate.

At the upper end of the gorge $40\frac{1}{2}$ miles from Great Salt Lake City, the mountains recede to the right and left, leaving a valley from one-half to three miles wide, and $15\frac{1}{2}$ miles in length.

Here the grading and bridging will not be expensive. Easy grades and curves of long radius are obtained.

There is rock for masonry at convenient distances on either side of the valley.

A limited supply of timber can be obtained in the cañons for cross-ties and bridge purposes.

The place from which a supply of timber for railroad purposes through the mountains can be procured, will hereafter be described.

From the upper end of this valley the mountains close in upon the river, forming a narrow crooked cañon six miles long. The river winds from side to side of the narrow gorge, making frequent crossings necessary. The excavation and bridging will be expensive. About one-half the excavation will be rock. Black limestone, carboniferous sandrock, and clay slate are the prevailing rocks.

Two short tunnels will be required, one at station 1,043, three hundred feet long, and one at station 1,085, four hundred feet long.

The high point crossed by the line at station 1,053 to 1,072, can be avoided on the located line. (See map and profile.)

In this cañon there is one mile that is very narrow.

The "*debris*," on both sides of the river, slopes to the water's edge. During storms of rain, or sudden melting of snow, great quantities of loose rock slide down the side of the mountains into the river.

Expensive retaining walls will be necessary to protect the road-bed.

From this place to the mouth of Echo Cañon ($5\frac{1}{2}$ miles) the

valley is wide and of a very uniform surface. Excavation and bridging not expensive. Stone, for what few bridges are required, can be obtained at convenient distances on both sides of the river.

Mineral coal was seen in place, in the Weber Valley, two miles below the mouth of Echo Creek.

The dip of the rock indicates that if coal is found north of this place it will be below the bed of Weber River.

Numerous indications of iron ore were seen. The farmers living in the Weber Valley informed me that there are large deposits of this mineral on one of the small tributaries of the Weber, on the north side of the river.

The altitude of Weber Valley, at the mouth of Echo Cañon, is 5,535 above the sea.

The average grade from the Devil's Gate, $29\frac{1}{2}$ miles, is $22\frac{2}{100}$ feet per mile. The grade is somewhat undulating, but generally very uniform, as a reference to the profile will show.

From the mouth of Weber Cañon to this place there will be sixteen bridges over Weber River. Some tributary streams and numerous irrigating ditches will have to be crossed.

I will here remark, that the profile of the line from Great Salt Lake City through the Wahsatch Mountains *via* Weber Valley to this place, $78\frac{3}{10}$ miles, is much more favorable than I expected to find.

From the mouth of Echo Cañon to the east branch of Sulphur Creek two lines were run—one *via* Echo Creek, crossing the divide between Weber and Bear Rivers, at the head of Echo; thence down a tributary of Bear River to the same, up Bear River to the mouth of Sulphur Creek, and up Sulphur to the east branch of the same stream. This line will hereafter be more fully described.

The other line continues up the valley of Weber River, $6\frac{44}{100}$ miles, without encountering any heavy work to the mouth of

CHALK, OR WHITE CLAY CREEK.

From information received from various sources before leaving Omaha, and after arriving in Utah, I was led to believe that this

S. B. REED DRY ENG'G & J. MATTHEWSON, DEL.

UNION PACIFIC RAIL ROAD

SURVEY OF 1864.

LITH. OF WALDO B. SWAMP, 440 BROOKLYN, N.Y.



WEBER RIVER CANON AT OVEN ROCK-ONE MILE ABOVE LOST CREEK LOOKING EAST.

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valley would prove to be the most favorable, if not the only practical route over the high divide between Weber and Bear Rivers. It was, therefore, with great anxiety that we worked our way up the valley of this stream to the summit.

The first two miles up Chalk Creek Valley is through well cultivated farms. Then the valley narrows to a cañon one mile in length, only wide enough for the bed of the stream and quite crooked. The rocky points from opposite sides of the creek projecting past each other will cause heavy rock excavation. From here the valley opens, and for a distance of $18\frac{1}{3}$ miles the excavation and embankment will be comparatively light.

The average ascending grade from the mouth of the creek to this place is $64\frac{32}{100}$ feet per mile, almost three times as much as the average in the Weber Valley above the Devil's Gate.

The approach to the summit is made with $5\frac{1}{4}$ miles of maximum grade. The excavation and embankment will be expensive. At the summit a tunnel, 2,700 feet in length, will be required, through carboniferous sand rock, with expensive approaches at each end.

The altitude is 7,834 feet above the sea. This is the highest point reached on the survey.

In the mountains, to the south, there is a large tract of pine timber, suitable for railroad purposes, accessible from this point.

From the summit to Bear River the country is very much cut up by the various small tributaries of Yellow Creek. It is necessary to cross the drainage with the line. This makes heavy work, as will be seen on the profile.

While exploring the country at the head of Chalk Creek, I became satisfied that it was impossible to cross the divide between Weber and Bear Rivers, south of Chalk Creek, on account of the near approach to the Uinta Mountains. Subsequent explorations fully confirm this opinion.

From Bear River, which is 130 feet wide and one foot deep at low water, to the east branch of Sulphur Creek, $11\frac{34}{100}$ miles, the grading and bridging is light, alignment good, and timber convenient.

As two lines were run to this place, I will return and describe some of the distinguishing features of the

ECHO CAÑON LINE.

Echo Cañon is a deep gorge worn in the soft sand rock, 100 to 1,000 feet wide, and $23\frac{1}{2}$ miles long. Bold escarpments rise almost vertical from five to eight hundred feet high, and extend on the north side from Weber Valley twenty miles up the cañon, or nearly to *Cache Cave*—on the south side the hills recede at an angle of 45° .

From Cache Cave to the summit the hills are more rounded, and slope back at a greater angle, numerous short tributaries come in on both sides, cutting the country into a succession of deep ravines and sharp ridges.

From the point where we leave the Weber Valley Line, up the cañon to Cache Cave, $21\frac{1}{2}$ miles, the work is light, material good, and grades not as objectionable as in Chalk Creek Valley.

The alignment is much better than the same distance up the valley of Chalk Creek.

The summit is reached with $3\frac{22}{100}$ miles of maximum grade, where a tunnel will have to be made 4,000 feet through soft sand rock.

The altitude of this summit is 6,879 feet above the sea. The average ascent per mile from the mouth of the cañon to the foot of the maximum grade, near Cache Cave, $21\frac{60}{100}$ miles, is $44\frac{90}{100}$ feet.

From the summit, the line was run down the valley of a small tributary of Bear River, to the same; thence up Bear River Valley and the valley of Sulphur Creek to its connection with the Chalk Creek line, $24\frac{45}{100}$ miles or $49\frac{20}{100}$ miles from the mouth of Echo cañon. The work on this last part of the line will be light. Rock for masonry convenient, and the alignment good.

By referring to the map and profile the relative merits of these two lines will be apparent.

The altitude of the summit on Echo Cañon line is 955 feet below the summit on Chalk Creek line.

The total ascending and descending grades, 1,020 feet in favor of Echo line. The alignment, excavation, and embankment is also largely in favor of this line.

Coal was seen on the Echo line in Bear River Valley, which it is believed will prove good for locomotive fuel.

The advantages of the Chalk Creek line are its proximity to large bodies of timber; its convenience to coal mines that are being worked in Chalk Creek Valley, and the difference in the length of the tunnels at the summit, which is 1,300 feet in favor of Chalk Creek line.

EAST BRANCH OF SULPHUR CREEK TO GREEN RIVER.

From this place to the summit, between the waters of the Great Salt Lake Basin and the Gulf of California, the line follows up a small tributary of Sulphur Creek two miles; thence over a low divide into the Valley of Quakingasp Creek—an affluent of Bear River,—and up that to its source on the divide, 124.87 miles from Great Salt Lake City.

From the summit we reach the Valley of the Muddy, an affluent of Black's Fork, in $7\frac{7}{10}$ miles; $2\frac{4}{10}$ miles of this is maximum grade. The altitude of the summit is 7,570 feet above tide.

The line was run down the Valley of the Muddy nearly to its junction with Black's Fork; thence 21 miles down the Valley of Black's Fork; thence over the divide, between Black's Fork and Green River, to that stream, which is $200\frac{3}{10}$ miles from Great Salt Lake City. From the rim of the Great Salt Lake Basin to Green River the work is generally light, and the material good. Very little rock excavation will be encountered on this portion of the line.

Immediately after crossing the summit there is a marked change in the topography of the country. Instead of the disturbed and upheaved rocks which characterize the region of the Great Salt Lake Basin; flat tables or terraces of horizontal strata now form the distinguishing feature of the country; sometimes standing alone, like islands, in the barren plains, or forming bold escarpments along the streams. The hills are fast wearing away under the influences of wind and rain.

In Green River Valley I made thorough exploration to the mouth of Bitter Creek, a distance of twenty miles. The valley is narrow, with bold escarpments on both sides of the river, rising in many places hundreds of feet, almost vertical from the water's edge.

To follow down the valley of Green River to Bitter Creek will require sixteen bridges over the river; otherwise the work would be light.

This involved an expense which I was anxious to avoid, if possible.

The only way that seemed practicable, was to cross the high table land between Green River and the north branch of Bitter Creek.

I traversed this country, but not as thoroughly as I wanted to do, an account of the hostility of the Indians, who were committing depredations on the whites in that vicinity while we were there. I recommend that a more thorough exploration be made from Green River to Bitter Creek before a final location is made.

From Green River to the north branch of Bitter Creek the grading will be expensive. Some rock excavation will be encountered, as shown on the profile.

This is over a desert country. No fresh water was found, and but very little grass for our animals.

From the place where we descend to the valley of the North Branch of Bitter Creek to Rock Springs, the point of connection with Mr. Evans' line, the grading and bridging is light.

It will be seen by an examination of the profile that to follow this line over the high table land the altitude to be overcome is very much increased.

From Great Salt Lake City, *via*. Echo Cañon line, to our connection with Mr. Evans' line in Bitter Creek Valley is 233⁴⁶ miles. The altitude at that point is 6,315 feet above the sea.

It will be observed that the profile shows a great preponderance of light work; there is a portion that is very heavy, but I think the work will compare favorably with the Baltimore and Ohio or Pennsylvania Central Railroads.

TIMPANOGOS VALLEY LINE.

This second line through the Wahsatch Mountains was commenced at a point in the Weber Valley line, near the mouth of Chalk Creek, and continued up the valley of Weber River, to and across Kamas Prairie, 26³⁸/₁₀₀ miles, to the Timpanogos Val-

ley. The work over this portion of the line will be very light, grades easy, and alignment good. Stone, for all the bridge structures required, convenient and abundant.

In order to conform as near as practicable to instructions, I made an extended reconnoissance of the valley of Weber River to its source, to satisfy myself beyond a doubt about the practicability of a line crossing the divide between Weber and Bear Rivers south of Chalk Creek.

My route was up the narrow valley of Weber River, in a northeasterly direction, 20 miles from Kamas Prairie, where the river is doubled back upon itself, and heads five miles east of Kamas Prairie. The high mountain range which forms the divide, is from 1,800 feet in the lowest pass, to 4,000 feet above Weber River. The summit appears to be not more than two miles from the river and is like a continuous solid wall. The watershed to the river is narrow and steep. The altitude of the lowest point on this divide is 9,162 feet above tide. I crossed over the divide to the west branch of Bear River, and followed up that stream in a southwesterly direction, fifteen miles, to its source. From a high point, the sides of which were covered with snow, I could trace the valleys of the various rivers that take their rise in the Uinta Mountains. On my return, I followed the crest of this divide a distance of twenty miles, to the place where I crossed it on my outward trip.

I am satisfied there is no possibility of getting a line over this divide without a tunnel at least three miles long, and at a much greater altitude than on the Chalk Creek line.

In the mountains I saw an abundance of white and Norway pine timber, suitable for railroad purposes. That growing on the Bear River slope is of easy access, and can be rafted down the river to the line.

On my return, we continued the line down the valley of Timpanogos River to the valley of Utah Lake.

Heavy work and $2\frac{27}{100}$ miles of maximum grade is encountered to get from Kamas Prairie down to the valley of the river. From thence, down the valley of the stream, $8\frac{61}{100}$ miles, the valley is narrow, and the grading and bridging will be expensive. From thence across Round Prairie, $11\frac{36}{100}$ miles, good grades, easy curves, and light work, are obtained.

From the west end of Round Prairie to the mouth of the cañon in Utah Lake Valley, $11\frac{8.3}{100}$ miles, the most difficult part of this line is encountered. The cañon is narrow, and, unlike Weber, is very crooked. The points, from opposite sides of the river, project past each other, making frequent crossings of the river necessary, and a constant succession of heavy rock excavations unavoidable.

The prevailing rocks are granite, lime and sand. No indications of coal were seen in this valley.

Thirty-four bridges will be required across the Timpanogos River.

The grade from the mouth of the cañon, to the foot of the maximum grade near Kamas Prairie, $31\frac{8.0}{100}$ miles, averages 40 feet per mile.

From the point where the Timpanogos River enters Utah Lake Valley, there is a wide table land or terrace extending from the mountains to the lake. We ascended from the Timpanogos Valley to this terrace, and run in a northwesterly direction through the thriving towns of Battle Creek, American Fork, and Lehi; crossed the *Jordan River* at the narrows, from thence over the extensive stock range on the west side of *Jordan* to the point of the *West Mountain*, which is 12 miles west of Great Salt Lake City. From thence westerly between the base of the *West Mountains*, and the Great Salt Lake, to the end of our line in Tuilla Valley, $106\frac{2.3}{100}$ miles, from the Weber Valley line, near the mouth of Chalk Creek.

An examination of the profile will show the work in Utah Lake Valley, and the valley of Great Salt Lake, with the exception of crossing the *Jordan River*, to be light. The grades and alignment are unobjectionable.

EXPLORATIONS.

During the summer, and after the above surveys were completed, I made extensive explorations of the Wahsatch, Uinta and Bear River Mountains.

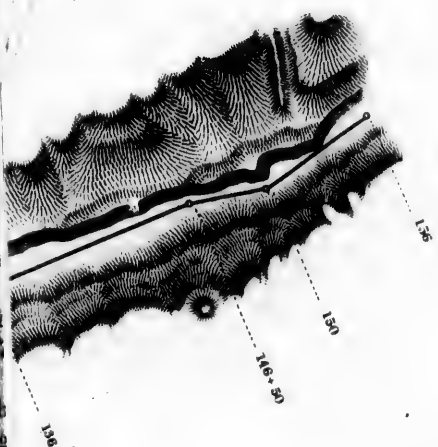
The Wahsatch range was crossed at every place where there seemed to be a possibility of finding a line through the mountains between Timpanogos and Weber Rivers.

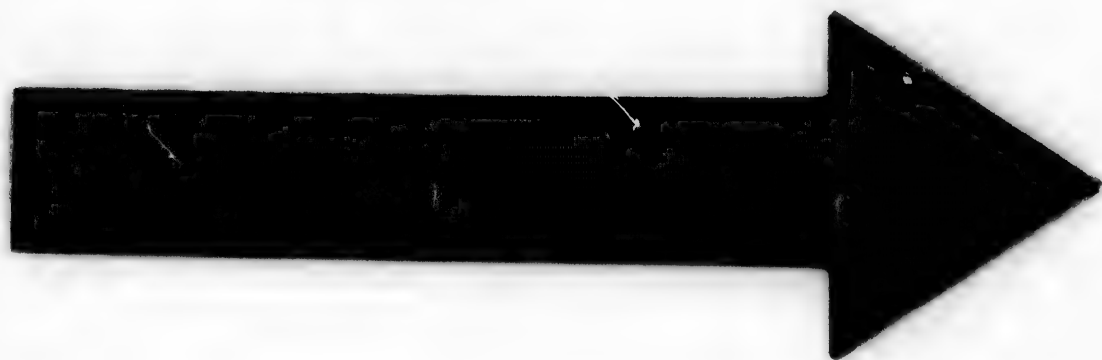


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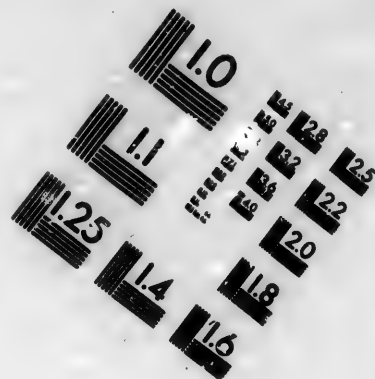
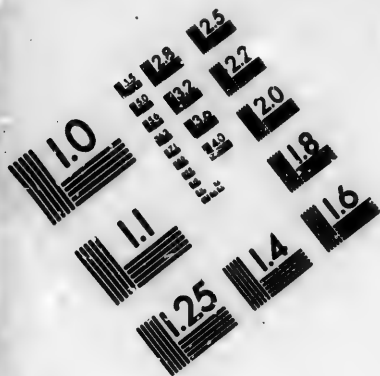
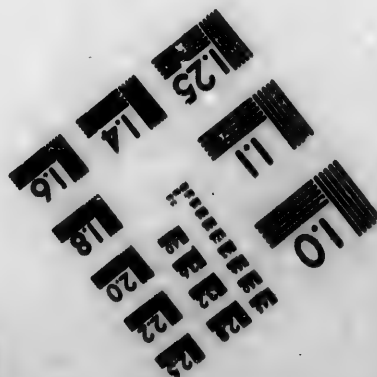
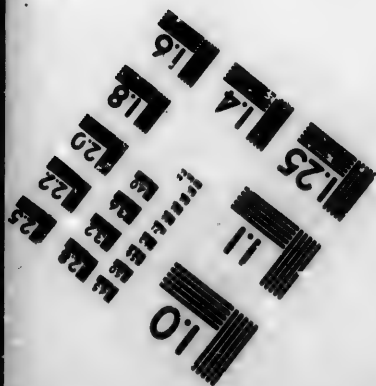
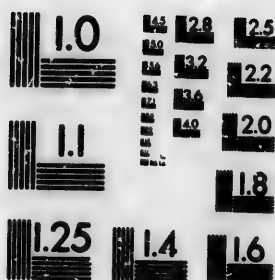


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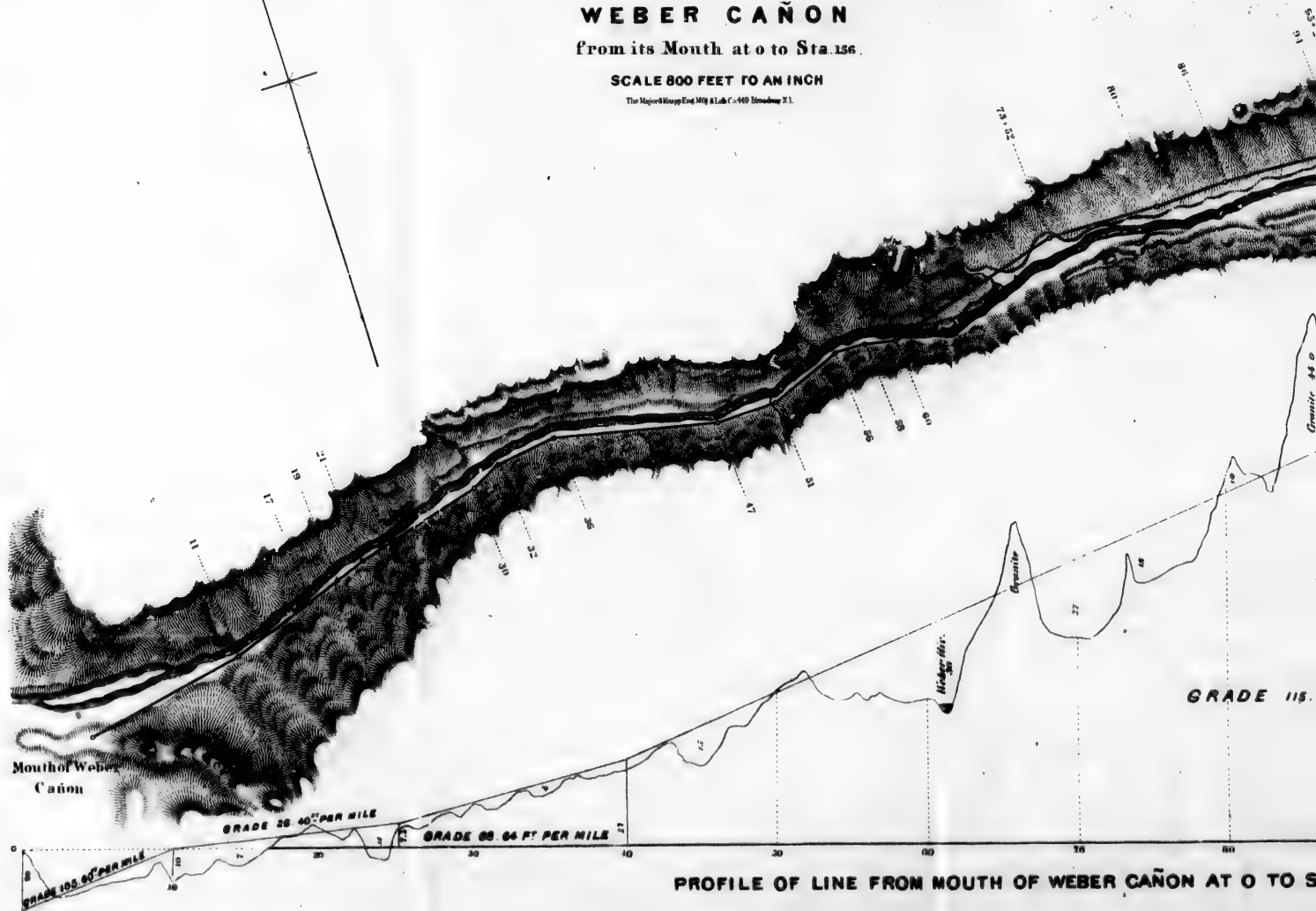
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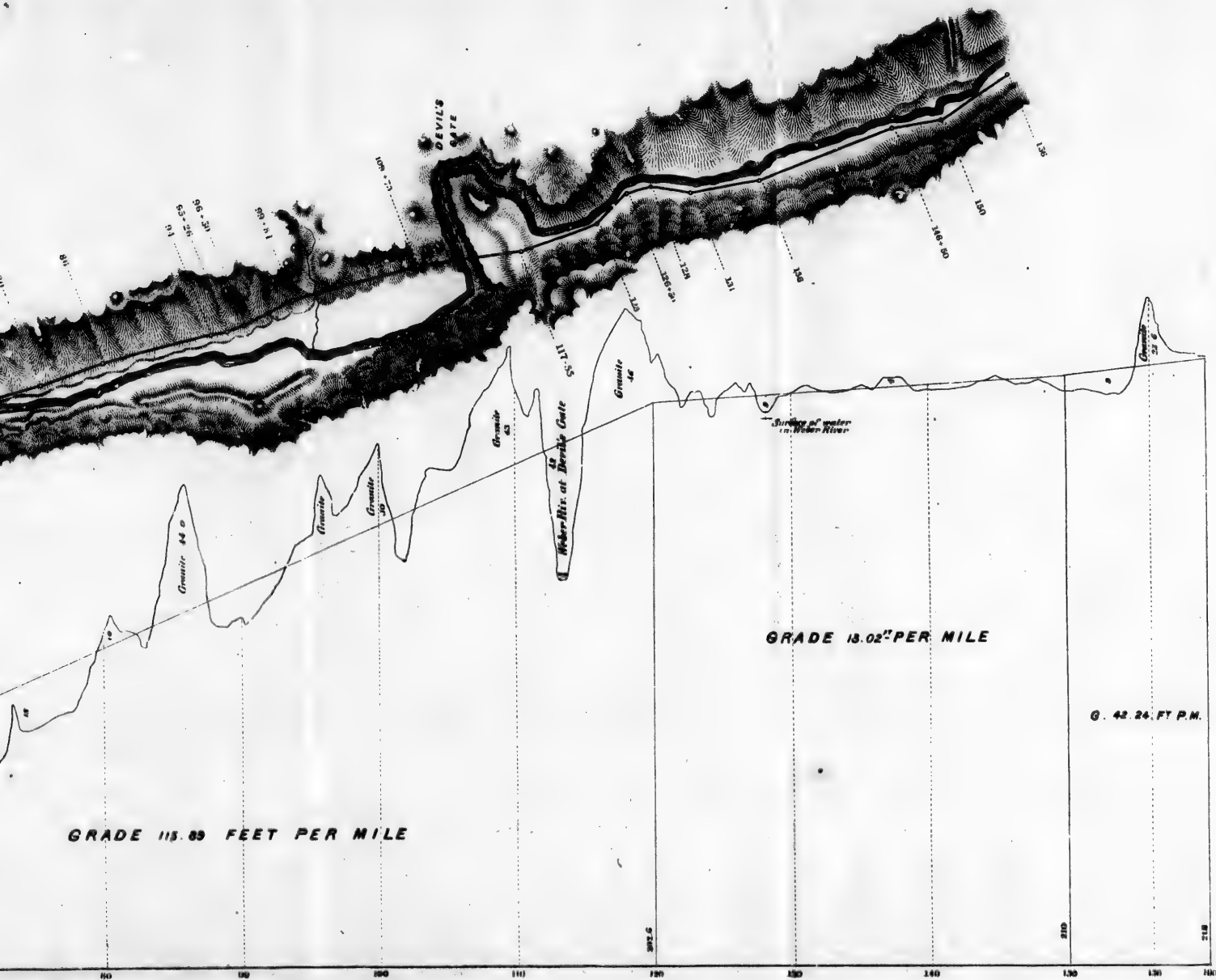
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SURVEY OF 1864
S. B. REED DIV. ENG'
WEBER CAÑON

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The Majors-Knapp Eng. Mfg. & Lbr. Co. 449 Broadway N.Y.





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SURVEY OF 1864.



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Between Weber and Bear Rivers I traversed the summit of the mountains from the head waters of the Timpanogos River, in the Uintas, north to the source of Lost Creek (known on Stanley's map as Pumbur Creek.) Echo Cañon Line crosses this divide in the lowest place on the range.

Between Bear River and Muddy, I followed the rim of the Great Salt Lake Basin, from the head of Sulphur Creek, in the Uinta Mountains, to the head waters of Ham's Fork, crossing with my line at the lowest place on this summit, which divides the waters of Great Salt Lake Basin from those of the Gulf of California.

From these explorations I am satisfied that I have shown the best line that can be found through the Wahsatch range, north of the Uintas, unless a line should be run down the valley of Bear River. This, if practicable, will increase the distance to Salt Lake Valley about 80 miles.

You will observe that I have confined myself to the maximum grade. When I could not overcome the various difficult summits that I encountered, I abandoned the survey and sought a new line.

TIMBER AND FUEL.

This is an important subject, and it was with great interest that I observed the various places from which a partial supply of timber can be obtained. Before exploring the Uinta Mountains, I looked upon the scarcity of timber as the most serious obstacle to be overcome in building the road through the mountains.

On the head waters of Bear River, contiguous to the various tributaries of that stream, there are large tracts of white and Norway pine, suitable for railroad purposes, that can be rafted down Bear River to the line.

I was informed by Mr. Granger, who lives on Ham's Fork, that there is a large tract of pine timber on Green River, 40 miles north of the crossing of that stream. If this information is correct, of which I have no doubt, cross-ties can be obtained from there, and rafted down Green River to the line, to build the road between Green and Bear Rivers.

In the Wahsatch Mountains a limited number of cross-ties and some bridge timber can be obtained.

Coal is abundant on Bitter Creek, Ham's Fork, Sulphur Creek, Chalk Creek, Weber and Bear Rivers.

Indications of coal were seen on the Muddy, Yellow Creek, and in Echo Cañon.

There are Petroleum springs in the valley of Sulphur Creek, and in Pioneer Cañon, about three miles north of the place where the line crosses the divide between Bear River and Muddy.

We closed our work and started for Omaha on the 28th day of October. We encountered severe storms in the mountains and on the plains, which prevented our reaching Omaha until the 18th day of November.

In conclusion, I wish to acknowledge my obligation to Governor Brigham Young for the courteous and gentlemanly treatment I received from him. To his cheerful and prompt compliance with all my requisitions for men, means of transportation, and subsistence, the company are in a great measure indebted for my success.

To Mr. Granger, for supplies loaned us, and for his valuable assistance in exploring the country in the vicinity of Black's Fork and Green River without charge.

To Mr. A. J. Mathewson, F. J. Paris, J. F. Smith, assistants, and all other members of the party I am obliged for valuable assistance rendered during the survey.

All of which is respectfully submitted.

SAMUEL B. REED,
Division Engineer.

To T. C. DURANT, Esq.,
Vice-Prest U. P. R. R. Co.,
No. 13 William St., New York.

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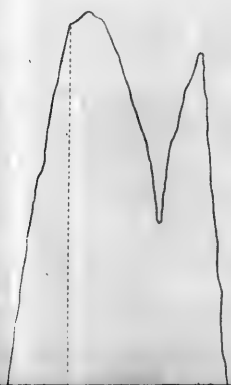
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UNION PACIFIC RAIL ROAD

Survey of 1864

S.B. REED DIV. ENG.

(SECTION OF WEBER CAÑON)

Station 990 to 1130

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OF 1864

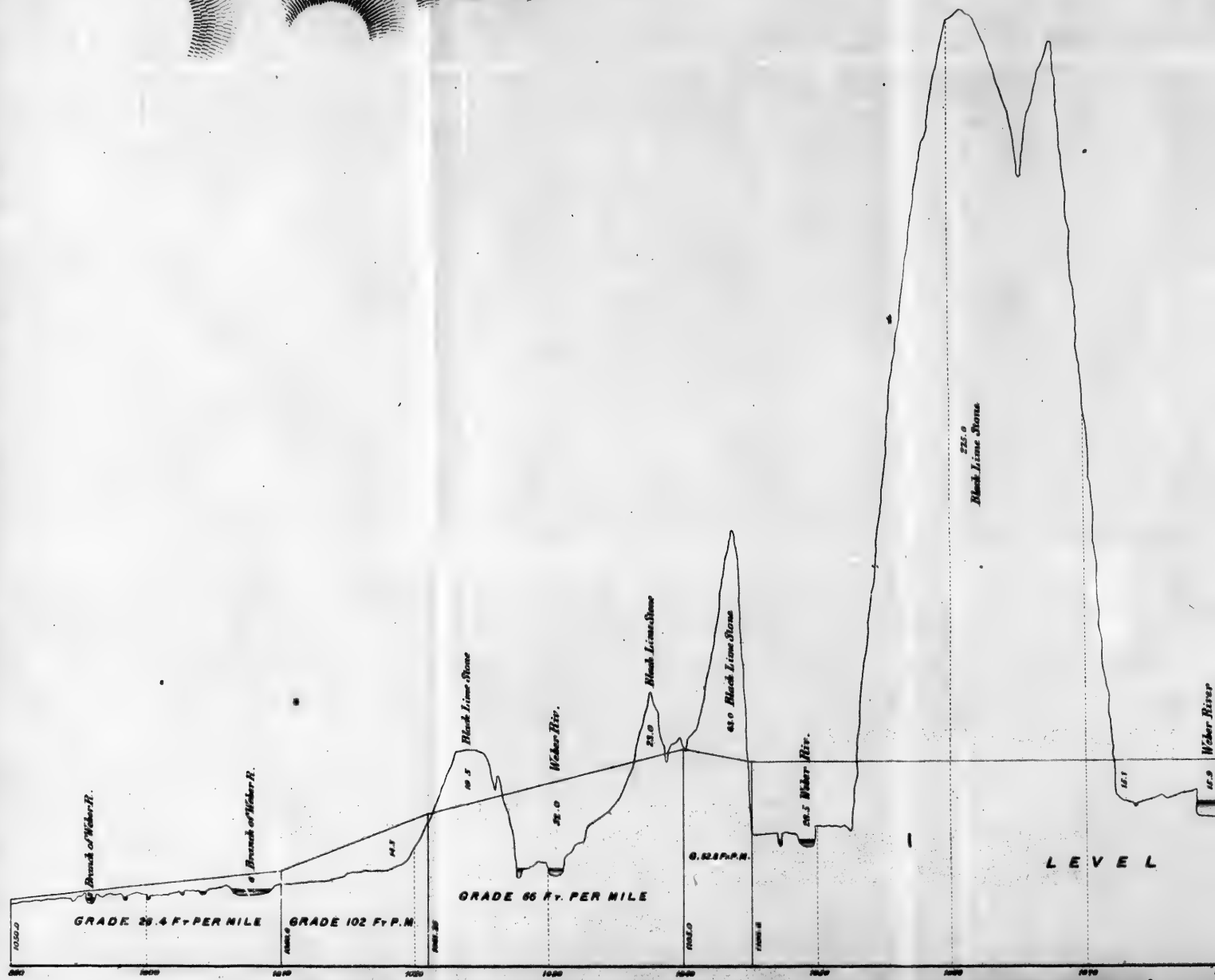
DIV. ENG.

BER CAÑON))

to 1150

TO AN INCH.

In 440 Broadway N.Y.



PROFILE OF SECTION OF WEBER CAÑON STATION 890 TO 1180

Similar { Horizontal line flat to one inch.
Vertical do flat to one inch.

UNION PACIFIC RAILROAD

Survey of 1864

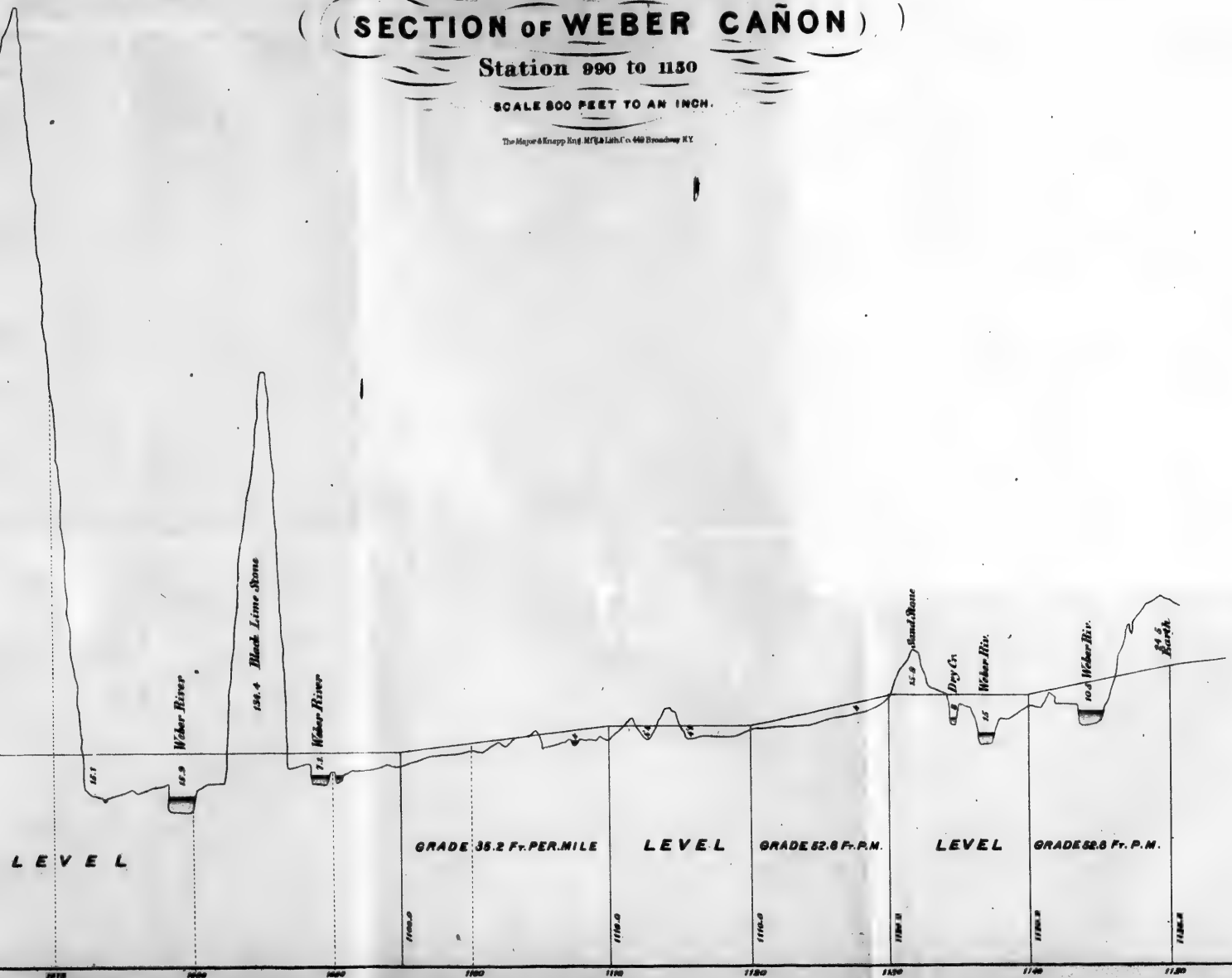
S.B. REED DIV. ENG.

(SECTION OF WEBER CAÑON)

Station 990 to 1150

SCALE 800 FEET TO AN INCH.

The Map & Engraving Co. 640 Broadway N.Y.



Vertical line 800 to one inch.
Horizontal line 800 to one inch.

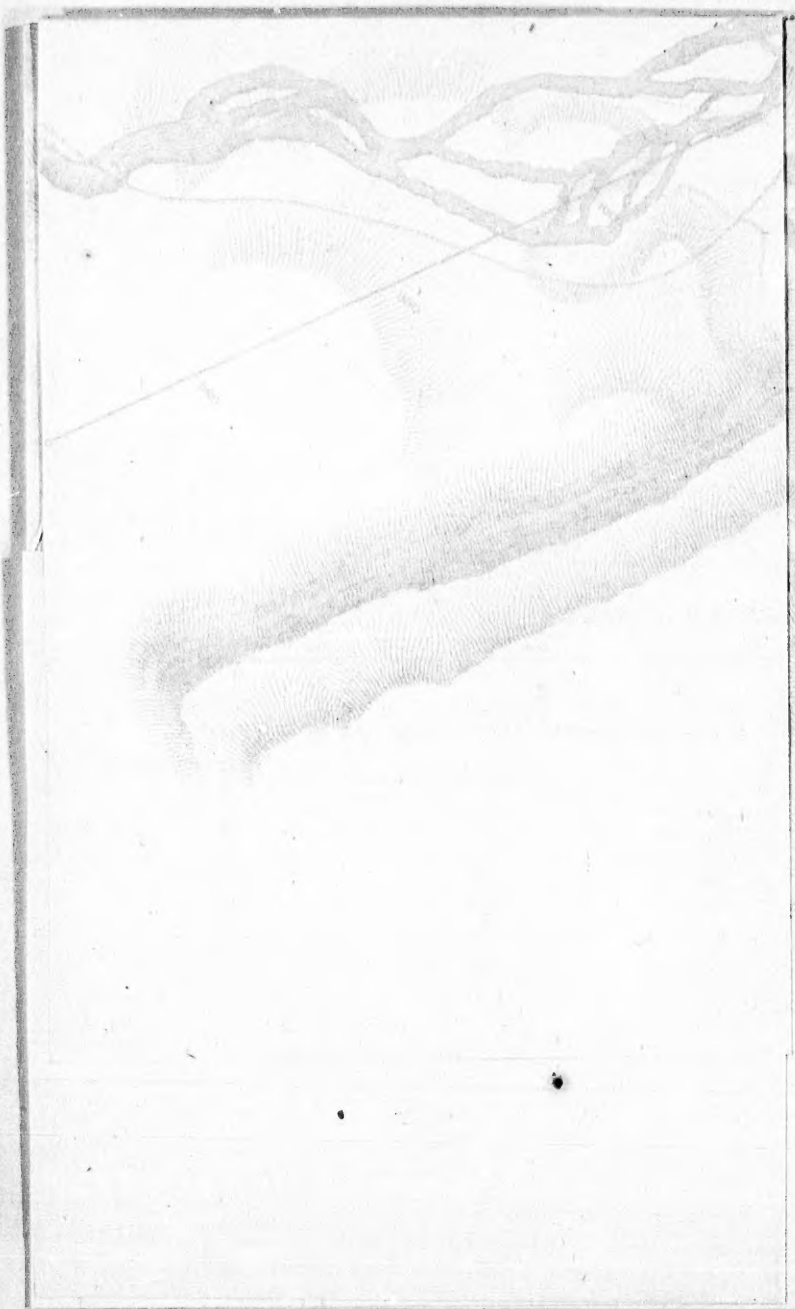


Table of Altitudes.

	Feet above the sea.
The end of the line in Great Salt Lake City.....	4285.8
“ mouth of Weber Cañon.....	4654.7
“ Devil's Gate, in Weber Cañon.....	4894.0
“ Weber Valley, at the mouth of Echo Cañon.....	5535.0
“ “ “ “ Chalk Creek.....	5645.0
“ summit at the head of Chalk Creek.....	7834.0
“ summit at the head of Echo Cañon.....	6879.4
“ surface of water in Bear River, on Chalk Creek line.....	7503.0
“ “ “ “ Echo Cañon line.....	7045.0
“ summit between Bear River and Muddy, the rim of Great Salt Lake Basin.....	7567.0
In the valley of Muddy, near the Overland Stage Station.....	7067.0
The surface of water in Black's Fork, two miles below the mouth of Muddy.....	6375.0
“ surface of water in Black's Fork, twenty miles below the above.....	6257.0
“ summit between Black's Fork and Green River....	6464.0
“ surface of water in Green River.....	6245.0
“ summit between Green River and north Branch of Bitter Creek.....	7175.0
“ Bitter Creek Valley, at the junction of Mr. Evan's line.....	6315.0

TIMPANOGOS LINE.

The end of the line in Tuilla Valley.....	4243.0
At the point of the West Mountain.....	4267.0
The surface of water in the Jordan River, at the Narrows.....	4522.0
In the Timpanogos Valley, at the mouth of the Cañon.....	4892.0
In the Timpanogos Valley, at Kamas Prairie.....	6391.0
On Kamas Prairie.....	6667.0
The surface of water in Weber River, at the north end of Kamas Prairie.....	6340.0
The mouth of Chalk Creek, in Weber Valley.....	5645.0

The principal bridges on the line, from Great Salt Lake City to Bitter Creek, *via* Echo Cañon line, are—

	Lineal feet.
16 Truss bridges over Weber River, of 250 feet each.....	4,000
5 " " small stream in Weber Valley of 100 ft. each	500
30 Bridges over Echo Creek, 40 feet each.....	1,200
6 " " Yellow Creek and branches, 40 ft. each..	240
Truss bridge over Bear River.....	100
30 Bridges over Muddy.....60 ft. each..	1,800
3 Truss bridges over Black's Fork.....300 "	900
1 " " " Green River.....	800
10 Bridges between Green River and Bitter Creek.....	400
	10,400

TIMPANOGOS LINE.

	Lineal feet.
1 Truss bridge over Jordan River.....	300
1 " " " American Fork.....	150
1 Bridge over Battle Creek.....	50
34 Truss bridges over Timpanogos, 300 feet each.....	10,200
3 " " " Weber River, 250 feet each.....	750
3 Bridges over Beaver Creek, 40 feet each.....	120
	11,570

In addition to the above, there will be numerous irrigating ditches and small streams to cross.

TABLE OF GRADES.

Level.	0 to 20 Ft. per Mile.				20 to 40 Ft. per Mile.				40 to 60 Ft. per Mile.				60 to 80 Ft. per Mile.				80 to 100 Ft. per Mile.				100 to 116 Ft. per Mile.					
	Distance, Miles.	Distance, Miles.	Total Ascent.	Total Descent.	Distance, Miles.	Total Ascent.	Distance, Miles.	Total Descent.	Distance, Miles.	Total Ascent.	Distance, Miles.	Total Descent.	Distance, Miles.	Total Ascent.	Distance, Miles.	Total Descent.	Distance, Miles.	Total Ascent.	Distance, Miles.	Total Descent.						
From Great Salt Lake City, via Weber Canon & Chalk Creek to Bitter Creek.....	25.54		382.5	32.27	917.2	23.21	638.4	16.89	571.1	13.71	722.6	10.32	1104.5	11.65	848.5	11.56	1020.4	2.00	190.0	15.73	172.02	11.37	1257.6			
		24.21	328.3	22.																						
From Great Salt Lake City, via Weber Valley & Echo Canon to Bitter Creek.	28.29		315.0	435.5	40.17	1202.6	24.17	650.4	20.57	1072.0	11.15	592.4	11.49	884.3	8.43	508.5	9.09	514.1	2.28	190.0	11.9	1279.4	10.16	1118.6		
		24.77	356.4																							
From Teulla Valley, via Point of View Mountain, Jordan River, Timpanogas Valley and Kansas City to Weber Valley near mouth of Chalk Creek....	9.39		4.58	58.0	8.43	124.0	12.97	852.0	12.06	348.0	13.69	702.0	11.57	618.0	5.19	363.0	12.88	884.2	21.5	208.0	5.30	517.0	0.72	76.0	7.10	779.

al feet.
4,000

500

1,200

240

600

1,800

900

800

400

10,400

eal feet.

300

150

50

10,200

750

120

11,570

igating